THE TELEGRAPHIC JOURNAL AND

Electrical Review.

VOL. XI.—No. 250.

ELECTRIC LIGHTING ON A LARGE SCALE.

OUR readers are for the most part fully acquainted with the electric lighting operations of the Edison Company on the Holborn Viaduct, with the additional extension of the system to the General Post-office. This is the most complete and best appointed arrangement of incandescent electric lighting yet seen in this country, and satisfactorily proves that its adaptation on as extensive a scale as gas is chiefly a question of first cost. We notice in the *Standard* of last Wednesday that its correspondent telegraphs as follows :—

NEW YORK, TUESDAY NIGHT.

Mr. Edison's system of providing an incandescent electric light for domestic use in a given district has just been put to a practical test in this city. The district selected occupies an area of nearly a square mile. Only one source of supply is provided, and that furnishes the illuminating power for sixteen thousand lamps, the electric current passing through 18 miles of mains. The result is that the severest demands which the consumers have been able to make upon the new system have been satisfied.

The *New York Herald* is using in its business premises an isolated plant on the same principle ; and the managers assure me that they are satisfied in respect to the commercial aspect of the question.

No new obstacle has presented itself to the success in practice of Mr. Edison's theory ; and scientific men will be interested to know that this first practical experiment demonstrates the soundness of the inventor's application of the multiple arc system, pure and simple, as distinguished from the series system, or the combination of the arc and series systems.

Throughout the entire district lighted as described, each lamp was independent of all the others. On the inquiry before the Select Commission of the British House of Commons, Dr. Siemens said it was impossible to supply electricity for domestic lighting from one source over a greater area than a square quarter of a mile. Last night, although only five thousand lamps were lighted, they were distributed over the entire district of the square mile. In the district there are fifteen hundred consumers of gas, of whom eleven hundred have subscribed for the electric light.

In the *Scientific American*, of August 26th, is to be found an illustrated description of this great installation of the Edison system, which varies in some details from the above. Additions, however, have probably been made since our contemporary's article was written. The district includes, according to our American authority, 946 consumers, and the number of lamps operated in connection with this scheme amount to no less than 14,311. Amongst the many interesting items forming part of this extensive undertaking we will merely allude to several of the most important. The Babcock and Wilson boilers are four in number, and can supply 250 horse-power each, and the electric current is produced by six of Edison's largest dynamo-electric machines. Each machine weighs complete (engine, dynamo, and base) 62,000 lbs. The field magnets weigh 33,000 lbs., and the armature 9,800 lbs. The length of this latter is 61, and its diameter 27·8, inches. The height of the machine from floor to top of field magnets is 6 ft. 4 in. The nominal capacity of each dynamo-electric machine is the production of 1,200 lights of 16 candle-power each ; but at their maximum it is stated they can each produce 50 per cent. in excess of this.

The current from all the machines is centred in two large copper bars with which the several street conductors are connected, and if from any cause it is supposed that one of the machines is not doing its work properly, it can be instantly disconnected from the rest by a huge switch which cuts it off from the main conductors. The presumably faulty machine is then joined up to 1,000 test lamps of 16 candle-power each, and if the current produced by the machine brings these lamps to brilliant incandescence, it is in usable condition. Of course if this desirable result is not attained the existing fault must be sought for by other means. The size of the conductors varies with the requirements, those in the street are equal to a copper rod of one-half inch in diameter, and the service conductors differ, some being equal to two, and others to ten, No. 10 wires. The street conductors are something over 14 miles in length. The field-magnets of the dynamos are placed in a shunt circuit derived from the main circuit, which includes a switch and a number of rheostat coils, one or more of which may be thrown into the shunt circuit, so as to add to the resistance of the shunt circuit from a small fraction of an ohm to seven and a half ohms, which is the greatest resistance necessary to control the current exciting the field-magnets, and thus control the current in the main circuit.

There is a set of resistance coils for each dynamo, each set being provided with a circular switch, operated by a horizontal shaft through sets of mitre gearing. An attendant is stationed at the wheel at the end of the horizontal shaft, and turns the switches one way or the other, according to the requirements. He is able to judge of the amount of current required by watching an indicator above the regulator. This indicator is provided with two lamps, one red and one blue, and with a device for throwing one or the other of them into the circuit, according as the current is strong or weak ; and neither lamp is illuminated when the current is normal. When the blue lamp is lit more resistance is required in the shunt circuit to reduce the amount of current passing through the wires of the field magnets, consequently the attendant turns the switch, throwing in one coil after another until the blue lamp ceases to shine. When the red lamp shines, the switch must be turned in the opposite direction to increase the power of the field magnet and to strengthen the current in the main circuit.

We believe the *Standard* correspondent is in error concerning the remarks he ascribes to Dr. Siemens. He merely suggested that one-fourth of a square mile would be a proper or convenient area to work from a centre, and we need scarcely remind the author of the telegram from which we quote that Dr. Siemens knows as well as Mr. Edison exactly what electricity *can* be made to do.

We have said sufficient to show the vastness and importance of this enterprise which appears likely to be a perfect success, and it is to be hoped that when the results of the Holborn Viaduct experiments are known they may be of such a nature as to induce London to follow the example of New York. Success in America will doubtless have a lively and beneficial effect upon electric lighting industries in England, which are apparently depressed for the moment.

THE LEVETT - MÜLLER ELECTRIC LIGHTING SYSTEM AND MULTIPLE CIRCUIT DYNAMO.

[We extract from the *Scientific American* the following description of a system of electric lighting which we think new to our readers.]

THE dynamo, which is shown in perspective in fig. 1 and in transverse section in fig. 2, is capable of yielding a number of separate and distinct currents, which may be employed in widely different kinds of work. The dynamo shown in the illustration furnishes four separate circuits, with electric currents for as many different uses. One current is used for the arc light, another for incandescent lights, another for the transmission of power, another for electroplating. By simply duplicating some of the parts of the machine, the number of different circuits supplied may be indefinitely extended, and the currents may be used interchangeably for the arc lights, incandescent lights, electric motors, electroplating, storage of electricity, ore separating, and in fact for any of the purposes to which electricity is applied. The production of a number of separate and distinct currents in one machine is a novel feature claimed by Mr. Müller, and one that is of great utility. For example, by using one of these machines a hotel may have arc lights in the halls, offices, and in front, while its parlours and private rooms may be supplied with incandescent lights, and power may be furnished for its various operations of the kitchen and laundry. Similarly, public and business buildings and private dwellings may be equipped, and steamers may be provided with arc lights for the decks and head lights, while the state rooms and cabins may be provided with the softer and mellower incandescent light.

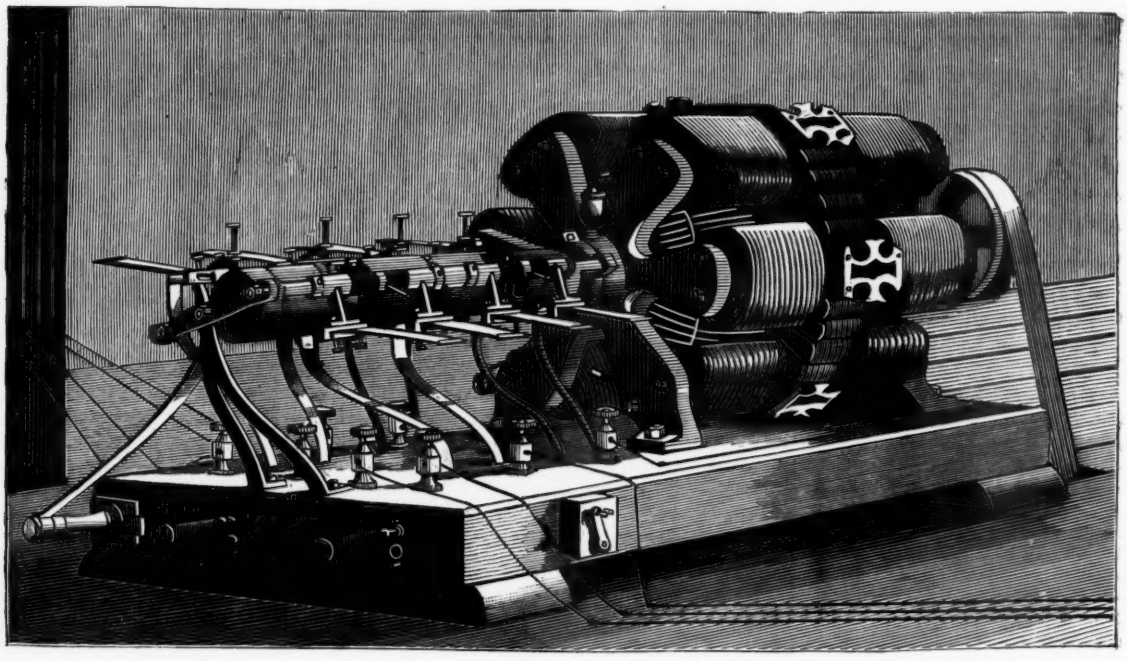


FIG. 1.

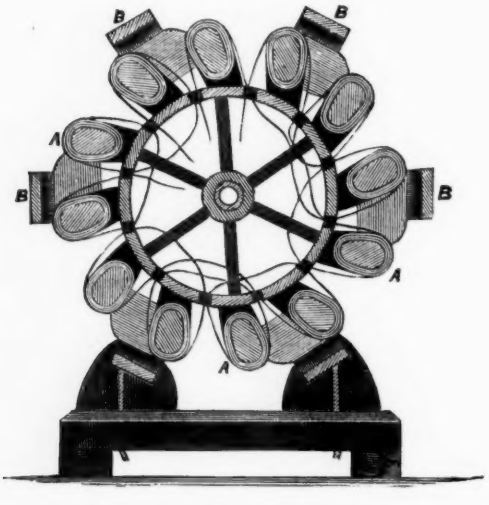


FIG. 2.

This desirable result is secured by employing a series of armature coils or bobbins, A, in an armature wheel rotating between the poles of two powerful multi-polar field magnets, B, the several bobbins being divided into series, each series being connected with a series of commutator bars, forming commutator cylinders, each being provided with a pair of collecting brushes, which deliver the current to the circuit upon which it is used.

To economise power the bobbins of the armature are arranged so that they are diagonal in relation to the poles of the field magnet. This plan allows the bobbins of the armatures to be removed from the vicinity poles of the field magnets with less force than would be required were the bobbins exactly radial.

The peculiar form of the armature wheel insures another important result—that is, the creation of a current of air throughout the machine, which keeps all of the parts cool.

The arrangement of the field magnets, armature bobbins, and connections is such that no bad effects are experienced from induction, the current in one circuit having absolutely no appreciable effect on that of another circuit.

This machine in ordinary working makes about seven or eight hundred revolutions a minute, and the lamps supplied by it seem to burn with absolute steadiness.

The arc lamp invented by Mr. Müller has a novel air check, which regulates the movement of the upper carbon. This, in connection with other new devices, renders the light very steady indeed. One form, which is shown partly in section in fig. 3, is of the same general construction as those burning single pairs of carbons, but made in duplicate, so at it will burn two, three, four, or more pairs of carbons in succession.

In this lamp, when the electric-arc is very small, there is very little resistance in the circuit, and the helix draws its core inward, raising the free end of the lever, A, as far as the upper screw will permit. This causes a pawl to engage with the ratchet-wheel of the feeding mechanism, which is rotated a short distance in the proper direction to raise the positive-carbon holder and lower the negative-carbon holder, thus separating the carbon points. This operation is repeated every time the carbons approach each other too much. The rapid descent of the carbons is prevented by

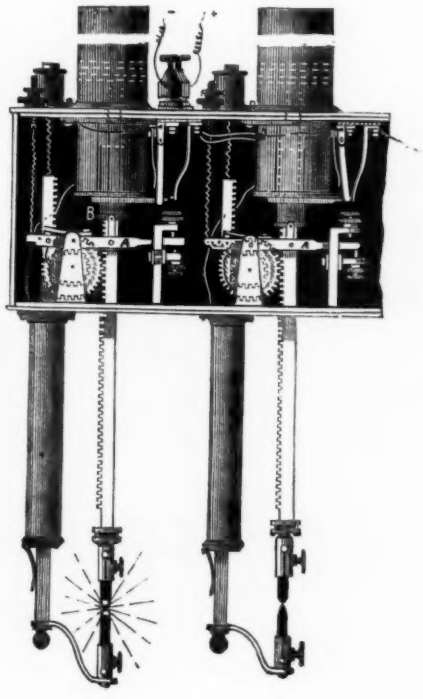


FIG. 3.

the piston attached to the upper or positive-carbon holder. The weight of the upper carbon and its holder, acting on the ratchet-wheel and its shaft, raises the lower carbon holder. As the positive carbon is consumed twice as rapidly as the negative carbon, the wheel which it moves must have twice the diameter of the wheel which moves the negative carbon. As long as there are any carbons in the first lamp, the current passes into the positive-carbon holder, the positive and negative carbons, the helix, the joint piece of the armature, and from there to the generator. During this time the armature at the side of the helix is attracted by the pole piece at the lower end of the helix. As soon as the first set of carbons is consumed to such an extent as to interrupt the circuit, the side armature is released from the pole-piece, and is pressed against a contact-strip which sends the current through the second set of carbons. As soon as the second set of carbons is consumed the armature of that lamp is released in the same way, sending the current to the third set, and so on.

It will be seen that by this ingenious arrangement the light may be made practically continuous.

Mr. Müller's incandescent lamp is shown partly in section in two views in fig. 4. In this lamp the inventor secures the following important results: first, replacing the carbon filament without breaking or rendering useless any part of the lamp; second, preventing the entrance of air through the joints between the plug and the conductors passing through it to the carbon filament.

The glass globe or bulb is provided with a flaring strengthened neck fitting very tightly on a bevelled glass stopper or plug, which is secured air-tight by means of packing material in a hollow base, D, adapted to be screwed on or otherwise attached to a bracket or chandelier arm. The glass plug and the neck of the globe are ground together, so as to fit air-tight against each other. A packing is placed around the plug and the edge of the neck as shown. Two carbon conductors of suitable thickness are passed through longitudinal openings in the glass plug projecting from the top and bottom of the plug, and secured in the plug by a suitable cement forming air-proof joints.

Copper rings are cast or blown into the top and bottom of the plug around the apertures through which the carbon conductors pass, and these rings project slightly from the ends of the plug. Copper is then precipitated by means of electricity around the projecting ends of the carbons and the rings. By this means the projecting ends of the carbons will be strengthened and prevented from being broken off, and the joint will be made air-tight.

The upper ends of the carbons are provided with slots into which the ends of a carbon filament are passed and secured by means of a peculiar cement. A glass seal tube

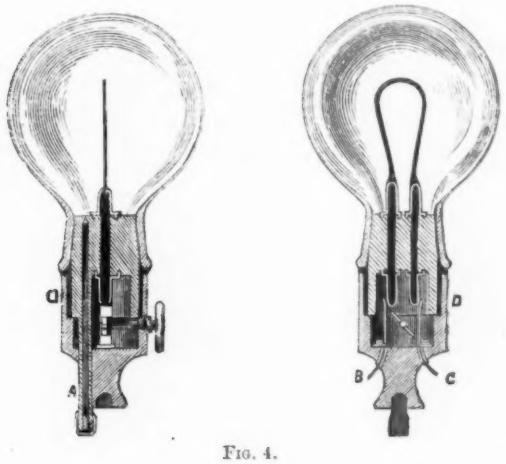


FIG. 4.

projects from the bottom of the plug through the base of the lamp, in which it is secured air-tight by means of cement. The end of this tube extends through the plug, and is contracted at its upper end. This tube is stopped at both ends, and the intervening space is filled with mercury.

Two insulated spring-contact strips project upward from the bottom of the recess in the lamp base, and rest against the lower projecting ends of the carbons. These strips are connected with conducting wires, B C, leading to the electric generator. A key journaled in the lamp base has at its inner end a crosspiece, which is of sufficient length to separate the strips and remove them from the ends of the carbons when it is in a horizontal position. When this crosspiece is in a vertical position the strips are released and rest against the ends of the carbons.

Should the carbon filament be destroyed or broken the globe is removed, a new filament is inserted, the globe is replaced, and the air is exhausted.

In addition to these interesting inventions, Mr. Müller has devised a very successful magnetic ore separator, and he has also perfected a storage battery for which great advantages are claimed.

LECTURES ON ELECTRIC LIGHT AND MOTIVE POWER.—Our readers probably noticed in the advertisement columns of our last issue that Mr. John C. Fell purposed delivering a course of eight elementary lectures on the above topic. These lectures commenced last Tuesday evening, and were continued on the following Thursday. The same course will be pursued during the next three weeks, the lectures being delivered in the Hall of the Society of Engineers, 6, Westminster Chambers. A syllabus of the course may be obtained of Fell and Wilding, 23, Rood Lane, E.C. Mr. Fell is well known to us as a science teacher, and his lectures are particularly well and clearly delivered. His long experience at the Birkbeck, and other literary and scientific institutions should enable him to give very concise and definite illustrations connected with his subject, and we can therefore safely assume that his young hearers will be materially benefited by what Mr. Fell has to say.

MEASURING INSTRUMENTS USED IN ELECTRIC LIGHTING AND TRANSMISSION OF POWER.

By Professors W. E. AYRTON, F.R.S., and JOHN PERRY, M.E.

[Read before the Society of Telegraph Engineers and of Electricians in May, 1882.]

DURING the last two years an enormous impetus has been given to the development of the electric light and electric transmission of power; and as accurate measurements form the basis of commercial success in this as in any other branch of engineering, we hope you may not find it too tedious listening to a short description of the details of certain instruments that we have devised and have had constructed for making accurately, and at the same time quickly, the measurements that are necessary to be made, in order that an estimate may be formed of the commercial success of any special system of electric lighting or transmission of power.

After the most charming paper given us at our last meeting, by Mr. Stroh, and of which the recollection must for a long time remain in all our minds, we feel that some apology is due to you for the rather prosy production which to-night follows it.

The chief objection to instruments used in measuring strong currents is that, first, the deflections are not proportional to the current, and, secondly, there is no easy method of calibrating the instrument—that is, ascertaining the strength of the current that is necessary to produce any given deflection. At the end of 1880, we tried in our "illuminator," used in connection with our apparatus for seeing by electricity, a method that has since been described by MM. Deprez and Carpentier, for making the deflection proportional to the current. This consisted in placing the axis of the coil, not, as is usual in galvanometers, at right angles to the axis of the permanent magnetic field, but at an acute angle with it, so that, instead of, as is usually the case in ordinary galvanometers, the magnetic moment due to the current diminishing as the needle is deflected, while that due to the permanent controlling field increases, and in consequence of which the current must increase much more rapidly than the deflection, our plan of sloping the coil causes the magnetic moment due to the currents to increase up to a certain point. But in our later instruments, indeed in all instruments with permanent magnetic fields that we have made since the commencement of 1881, we have abandoned this method in favour of giving to the coil, needle, and pole-pieces exactly the shape that theory shows to be necessary to obtain deflections exactly proportional to the current.

1. *Commutator Ammeter.*

Last year we had the honour of bringing before the society an instrument by means of which strong electric light currents can be measured, and yet which can be calibrated by the employment of a single Daniell's cell. This instrument, which we have since called an "ammeter," short for ampère-meter, contains, as the members will remember, a coil consisting of 10 strands, each of exactly the same resistance. These 10 strands, by means of a simple commutator, can be joined either in series or in parallel circuit, and so the sensibility of the instrument can be increased exactly 10 times without altering the dead-beat character of the instrument, which latter is produced by the extreme lightness of the needle and corrugated aluminium pointer and by the great strength of the magnetic field.

To calibrate the ammeter, the commutator is turned to series, and a current sent through the instrument by a cell of known electromotive force, E, but of unknown resistance, producing, say, a deflection, D; the plug attached to the instrument is now taken out,

COMMUTATOR AMMETER AND VOLTMETER.

which has the effect of adding a resistance of one ohm to the circuit, and a second deflection D_2 obtained. From this it can easily be shown that a current of $10\,\frac{D_1 - D_2}{D_1\ D_2}$ E ampères will produce 10° deflection when the commutator is in series, or 1° deflection when the commutator is to parallel.

Many of the instruments are adjusted to give one ampère per degree when the commutator is to parallel; others, again, are arranged to give two ampères per degree; while some go as high as five ampères per degree, and therefore measure currents of over 200 ampères.

In designing this commutator ammeter, we originally only thought of using the high grade of sensibility for the purpose of calibrating the instrument, but we have found it extremely convenient when testing the comparatively small currents of 0·5 to two ampères used with incandescent lamps.

2. *Commutator Voltmeter.*

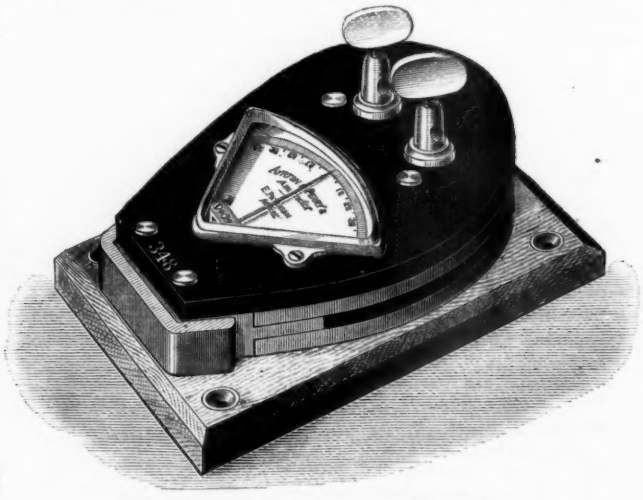
Since the reading of that paper, we have constructed a commutator voltmeter on much the same principle, but in this case each coil has a resistance of 40 ohms, so that when in series the instrument has 400 ohms resistance, and when parallel only four ohms, whereas in the ammeter the resistance in series is about 0·3 ohms and parallel 0·005, the latter being more than one-hundredth of the former, in consequence of the resistance of the small leading wires inside the instruments.* The ammeter is calibrated in series and generally used in parallel circuit, whereas the voltmeter is calibrated in parallel circuit and used generally in series, and indicates from one volt per degree in some instruments to five volts per degree in others, the total deflection of 45° in the latter case corresponding with 225 volts. But just as the ammeter can be conveniently used in series, when testing the comparatively small currents passing through a single incandescent lamp, so the voltmeter may be used in parallel circuit for testing electromotive forces of two or three volts, such as, for example, the electromotive forces of one or two Faure's accumulators. To calibrate the voltmeter, the commutator is turned to *parallel*, and a current sent through the instrument by a cell of known electromotive force, E, but of unknown resistance, producing, say, a deflection of D_1; the plug attached to the instrument is now taken out, which has the effect of adding a resistance of four ohms, and a second deflection, D_2, obtained. From this it can easily be proved that an electromotive force $10\,\frac{D_1 - D_2}{D_1\ D_2}$ E volts between he terminals of the instrument will produce a deflection of 10° when the commutator is to parallel, or 1° when to series.

In the ammeter the resistance coil can be introduced in the circuit *only* when the commutator is to series, and in the voltmeter *only* when to parallel, so that in neither case can it be fused by the plug being accidentally taken or left out when a strong current, or, in the second case, a large electromotive force, is being measured. And more than this, to avoid the coils of the instrument itself being fused, or the needle being damaged by the instruments being arranged for maximum sensibility when currents or electromotive forces suitable for the 1-10th sensibility of the instrument are being measured, each instrument is provided with three binding screws marked respectively s (P s), and P, as seen in the figure. In all the newer ammeters the screw, P, is suitable for a thick wire, and s only for a thin, (P s) being suitable for either. Hence the wires from a dynamo, for example, can only be attached to (P s) and P, and not possibly to s. Now a current can only pass through the instrument from (P s) to (P) when the commutator is to parallel. Hence, if accidentally left to series, the circuit is merely interrupted, instead of the coils being fused or the pointer damaged by too large a deflection. Precautions of a similar kind are also taken in the construction of the voltmeter, by the use of three distinct binding screws on the instrument.

All the instruments are so wound that, when a current is sent from binding screw to binding screw, at each side of the commutator, the pointer points to that binding screw at which the positive current enters.

3. *Non-Commutator Ammeter and Voltmeter.*

In electric light factories or other places where many ammeters or voltmeters are employed, it is of course unnecessary that all should be provided with commutators for easy independent calibration. It is sufficient that a few of the ammeters and voltmeters should have



NON-COMMUTATOR AMMETER AND VOLTMETER.

commutators for independent calibration, the remainder, which in that case are made as shown in the following figure, being calibrated by direct comparison with the commutator ones.

In all our instruments the needle and pointer are pivoted by an

* The voltmeters are now made with each coil having a resistance of 200 ohms, so that the instrument in series has a resistance of 2,000 ohms, and in parallel circuit, 20 ohms, the resistance coil being also of 20 ohms.

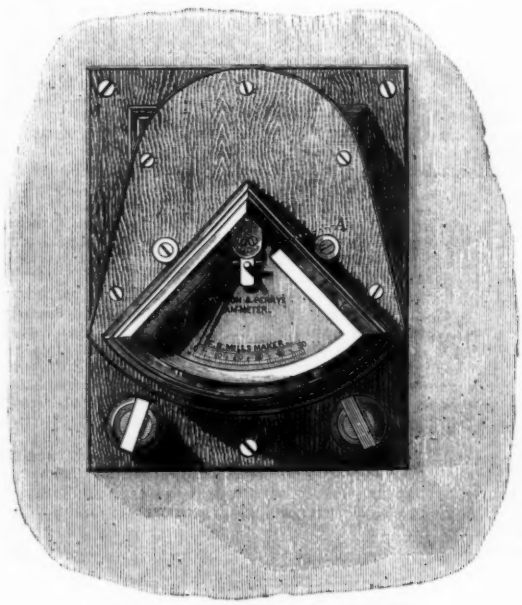
axis passing through their common centre of gravity, so that the deflexion is unaltered, no matter in what position the instrument be held, and the pivot resting in jewels top and bottom, the friction is also practically unaltered by turning the instrument on its side or holding it upright. The permanent attached magnet is also so strong, that the ammeters or voltmeters may be placed not very far from even a dynamo machine in action, without the magnetism of the machine affecting the indication of the instruments.

One difficulty, however, has practically arisen in the use of these instruments, and that is, although the special mode of winding adopted, combined with the existence of the commutator, enables any one by means of a single good Daniell's cell to calibrate his instrument for himself, practically Daniell cells do not exist at many places where there are electric light installations, and consequently people do not calibrate their instruments for themselves, and so do not detect the changes of magnetism in the permanent magnets which necessarily occur, and against which the user is warned by a notice stuck in the lid of the box accompanying every ammeter or voltmeter.

To partially avoid the loss of magnetism in the controlling permanent magnets, an armature, seen in the last figure, is supplied with each instrument, but which of course must be removed when the instrument is in use.

4. *Spring Ammeter and Voltmeter.*

To however completely overcome this difficulty of loss of magnetism in the permanent magnets, we have decided to abandon permanent controlling magnets, and so we have constructed ammeters and voltmeters like those shown in the following figure, and in which the controlling force is that of either a flat or a cylindrical spiral spring, A, the axis of the soft iron needle in this case making an angle less than a right angle with the axis of the coil when no current is



SPRING AMMETER AND VOLTMETER.

passing, since if it made a right angle it would be in unstable equilibrium when a current passed. The best angle that the axis of the needle should make with the axis of the coil when the pointer points to nought, we have determined partly by calculation and partly by a long course of experiments, and we find that, with a proper initial adjustment, we can obtain deflections of the pointer up to 45° *directly* proportional to the current.

These instruments possess two important advantages not possessed by any of our earlier forms—the one being that they can be used with reverse currents; the second, that by giving any special set to the spring (for doing which there is a small hand, seen in the figure, and which can be turned through any angle indicated by a small graduated scale, A, under it), the needle does not start from the zero position until the current in the ammeter or electromotive force in the voltmeter exceeds a certain pre-arranged limit. This method of giving a set to the spring greatly increases the sensibility of the instrument. Suppose, for example, currents of about 30 ampères, or currents varying, say, from 25 to 35 ampères, are to be measured with a special instrument, then instead of the pointer starting from nought for even a small current, a set is given to the spring, so that the pointer does not leave the zero until a current of 25 ampères traverses the coils. In the former case, the spring would have to be so strong that the total possible deflection, 45 degrees, was produced by the 35 ampères—that is about 1·3° per ampère; whereas, in the latter case, a weaker spring set-up would be used, such as to be deflected through the 45° for an addition of 10 ampères to the 25 necessary to start the pointer. In the latter case, we should have 4° per ampère, or a sensibility about three times as great as before.

Spring voltmeters on a similar principle we have also had made.

5. *Wheel and Pinion Ammeter and Voltmeter.*

Where still greater delicacy is required, the form of the instrument is somewhat changed. Attached to the arbor of the needle is a wheel, W, with extremely finely-cut teeth gearing into those of a pinion, P, on the arbor to which the pointer is attached. With this arrangement the motion of the pointer is magnified ten times. If, then, the coil and needle have such a shape, and the axis of the needle makes such a proper initial angle with the axis of the coil that the deflection of the needle up to not more than even 36° is proportional to the current, then with our wheel and pinion arrangement the deflection of the pointer over the entire scale of 360° will be proportional to the current. In addition to these, both the arbor of the needle as well as the arbor of the pinion are provided with very delicate cylindrical spiral springs, S, S′, one or both of which may be employed, since the latter can be thrown out of gear by raising the arm, A, which is done by turning the head; H, of the adjusting screw. If both the springs be of the same strength, then the sensibility of the instrument can be instantly made exactly one hundred times as great by turning the milled head, H, which raises the arm, A, and throws S′ out of gear, or can be increased to any other known less or greater pre-arranged amount, by having the spring on the pinion weaker or stronger than that on the wheel.

Both springs have, further, little hands, *h*, *h′* (seen in the figure), for setting them up, so that the whole deflection of 360° may, if desired, be produced by a small percentage of change in the total current when it is wished to measure accurately small changes in a fairly constant current. The wheel and pinion ammeter, then, furnishes an instrument for the measurement of strong currents, comparable in delicacy with the instruments usually employed for the measurement of only weak currents. Every bearing is jewelled as it is in a good watch, hence the freedom of motion is very great.

An ammeter on this principle we are now constructing, to measure p to 1,200 ampères.

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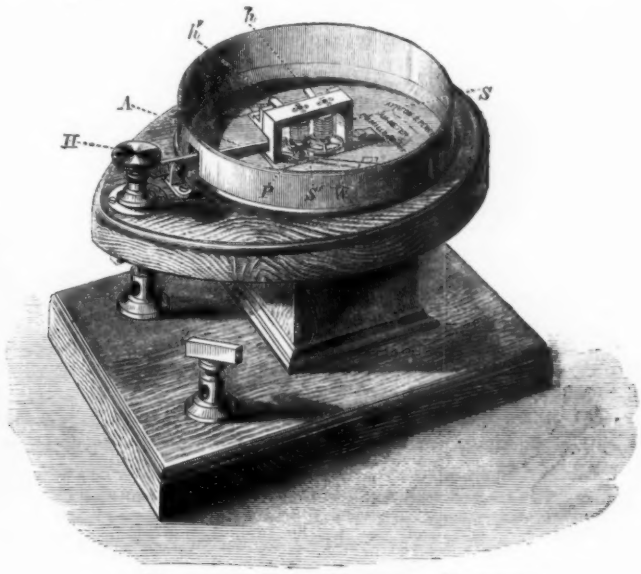


WHEEL AND PINION AMMETER AND VOLTMETER.

On a similar principle, we have constructed wheel and pinion voltmeters, with two grades of sensibility, for measuring electromotive forces with great accuracy.

By means of simultaneous measurements of the currents flowing through a circuit, and the difference of potentials between its two ends, the horse-power electrically given to that circuit can be ascertained, since this horse-power equals A × V × ·00134, where A is the current in ampères and V the difference of potentials in volts; also A × V × 44·25 equals the number of foot-pounds of work per minute electrically given to that part of the circuit.

6. *Bifilar Suspension Electric Power Meter.*

In the paper read by us last spring at the Society of Arts, we described an electric power meter which we had arranged for measuring by one observation the horse-power electrically given to any part of the circuit, and which, by the employment of our commutator principle, could be calibrated by employing very much smaller powers than the instrument was intended to usually measure. At the York meeting of the British Association, we exibited the instrument which we had been employing for this purpose, consisting of a coil of very fine wire wound on a long thin bobbin, so that the coil had a very small moment of inertia, capable of moving about an axis parallel to the length of the bobbin. The coil was bifilarly suspended inside another fixed coil containing 10 thick wires, each of exactly the same resistance, and which, by means of the commutator, could all be joined up in series or in parallel.

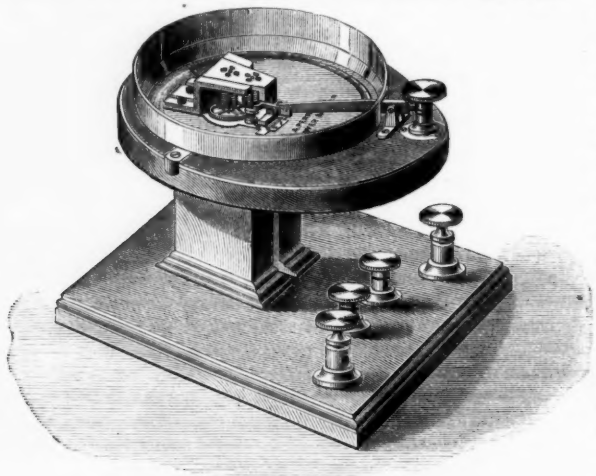
The thick wire coil is placed in the main circuit, while the fine wire coil acts as shunt to that part of the circuit, P, Q, the horse-power electrically given to which it is desired to measure. The current passing through this fine wire coil therefore measures V, the difference of potentials between P and Q, hence the deflection of the coil measures the product of the main current, A and V, and consequently

the horse-power being electrically given to P, Q. By turning the commutator to series, the sensibility of the instrument can be increased exactly ten times, either for the purpose of calibration, or when it is required to measure the power being given to, say, one incandescent light.

At the same meeting of the British Association, Sir William Thomson, before seeing our electric power meter, described an instrument he proposed constructing on the same principle, and which he called an electro-ergometer. We have not employed this name, because it appears to us to be not quite apt, since such an instrument measures the rate of doing work which is power, and not the *ergs* or amount of work done.

7. *Wheel and Pinion Electric Power Meter.*

This year we have modified our electric power meter, employing the wheel and pinion and double spring already described in connection with the wheel and pinion ammeter and voltmeter, so that this instrument now takes the shape shown in the following figure.



WHEEL AND PINION ELECTRIC POWER METER.

The outer and larger binding screws are for taking the wires which form part of the main circuit; the inner smaller binding screws for the finer shunt wires which are attached to that part of the circuit, the energy electrically expended in which it is desired to measure. One or both springs can be employed, and so two very different grades of sensibility are possible; also a definite amount of angular set can be given to either, so that a small change in a large horse-power will cause a great change in the deflection of the pointer.

8. *Transmission Dynamometer and Dynamometer Coupling.*

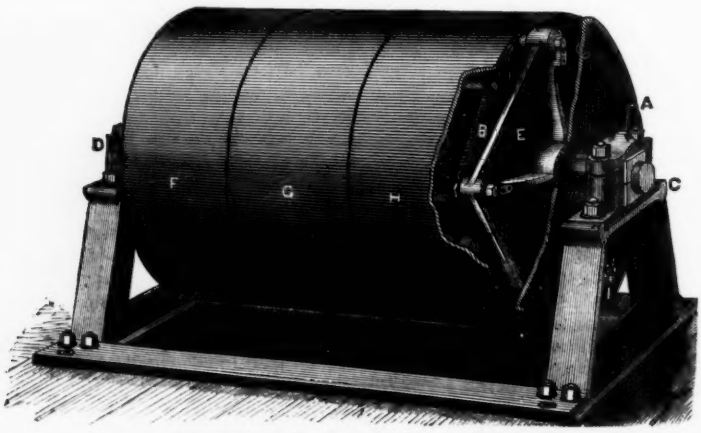
When describing our original ammeter to this society, we described a form of transmission dynamometer we had devised for measuring the power given by an engine to a dynamo or to any other driven machine, and to this instrument we have recently added the same contrivance of a set up spring used in the wheel and pinion ammeter and electric power meter, to limit the whole range of the instrument to not very large changes on each side of the normal horse-power to be measured, and by this means to obtain with a limited scale great delicacy near the normal measured power. The instrument, as seen in the figure,* consists of a pulley, F, rigidly fixed to the shaft, C D, a loose pulley, G, and a pulley, H, joined by the spiral springs, B, to the ribbed plate, E, which is rigidly fixed to the shaft, C D. If, then, the engine belt is on F, and the belt to the dynamo or driven machine on H, or *vice versâ*, the springs, B, will be stretched, depending on the "torque" or twist transmitted. The extension of these springs causes, by means of a small link-motion seen at the lower right hand curve of the figure, the bright bead, A, at the end of a long arm to approach the centre. Hence the smaller the radius of the circle described by this bright bead as it revolves, the greater the torque. Consequently, the horse-power transmited is at once obtained from observing the indicated torque and the speed of rotation. The arm carrying the bead is slightly flexible, and when no power is being transmitted the bead is pressed with a certain force against the rim of the front plate, hence the bead does not commence moving until a certain pre-arranged horse-power at a given speed is being transmitted; its whole radial motion, therefore, is completed for a certain additional transmitted horse-power, the necessary addition depending on the power of the springs and the leverage of the link motion. Consequently, a large change in the radius of the circle of light is produced by a small change in the transmitted horse-power. Further, one of the pins in the links can be taken out and put into another hole, which has the effect of greatly altering the leverage of the links, thus increasing the magnification and causing the motion of the bead to be completed for another range of power. For example, the springs and link motion may be so arranged that with one of the two adjustments the bead may commence to move when eight horse-power is being transmitted at a certain speed; the whole motion from the circumference to the centre may be completed, when the horse-power transmitted varies from eight to 12. With the other adjustment, the bead may start moving when four horse-power is being transmitted, and the entire travel of the bead from the circumference to centre completed by this transmitted horse-power increasing from four to six. Slipping either the driving or the driven belt on to the loose pulley, G, causes the transmission dynamometer and the dynamo machine to stop while the engine is going on.

The next figure shows our dynamometer coupling, which differs only from the preceding in that it is intended to be used with machinery driven directly by shafting where belting is not employed. For instance, this coupling may be used to measure the horse-power given by a fast-speed engine to a dynamo driven directly by it, or it may be employed to measure the power given by a marine engine to the screw or to the paddles, or generally the horse-power transmitted along any line of shafting; the spring coupling, in fact, replacing the ordinary coupling used with such shafts.

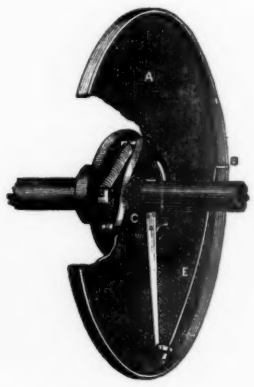
One of the halves of the coupling seen in the figure is keyed to the driving shaft—for example, the shaft of a fast-speed engine—and the other to the driven shaft—for example, that of the dynamo. The half, C, is attached to the other half by means of the spiral springs, and the stretching of these is therefore a measure of the torque. The angular motion of the one relatively to the other causes the bright bead, B, to approach the centre, and, as before, the radius of the circle of light measures the horse-power transmitted at any particular speed. The arm, E, carrying the bead, is also, as before, slightly flexible, so that when no power is being transmitted the bead, B, is pressed with a certain force against the rim of the larger plate. Hence the bead does not commence to move until a certain pre-arranged horse-power, at a given speed, is being transmitted, and the whole motion is completed for any pre-arranged excess beyond this, thus enabling delicate measurements to be made at powers a little more or less than that normally transmitted.

By a proper arrangement of the link-motions, we have succeeded in making the radial motion of the bead in both instruments exactly proportional to the extension of the springs or twist transmitted.

The transmission dynamometer and dynamometer coupling just described have the great advantage over any sort of laboratory dynamometers, in that the former have not to be put into position and adjusted for each particular experiment, but are always ready and are always indicating the power transmitted at any given speed. If, for example, a dynamometer coupling be inserted in the shafting of a factory in place of the ordinary coupling, a glance at it at any time will show the power that is being transmitted by it. If two such dynamometer couplings be inserted at two places in the same set of shafting, the difference between the transmitted powers indicated by



TRANSMISSION DYNAMOMETER.



DYNAMOMETER COUPLING.

* This and the following figure are from blocks used in Professor Perry's book on "Practical Mechanics," about to be issued by Messrs. Cassell, Petter, and Galpin, who have kindly granted us the use in advance of these two illustrations.

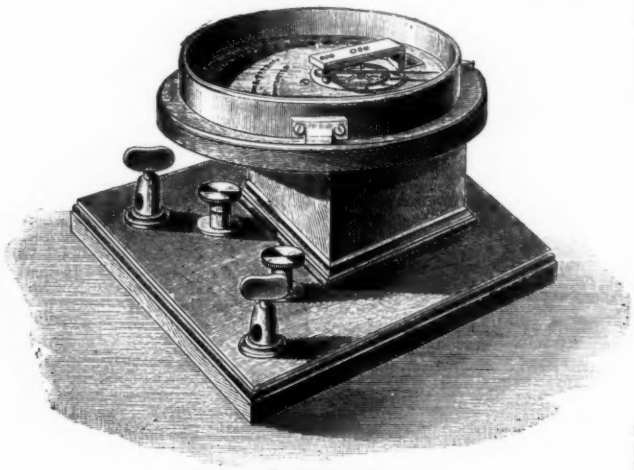
them is the power utilised by the machinery driven by that portion of the shafting that is between them. At present, masters of works, we think, have necessarily but rather a vague idea of the amount of power expended in different parts of their works—how much, for example, is used to drive one portion of the machinery and how much to drive some other. The substitution of a few dynamometer couplings, at well-chosen places, for the ordinary couplings, would settle this question.

9. *Ohmmeter.*

The next instrument, which, like all the preceding electric ones, is constructed by Messrs. Paterson, of 76, Little Britain, is for the purpose of measuring the resistance of any part of, say, an electric light circuit, while the strong current is flowing. At present the resistances of the field magnets, the bobbins of electric lamps, &c., are measured with the Wheatstone's bridge when cold, and a guess is made at their resistance when hot by making a rough estimate of the temperature. A better plan than this is to stop the current, and quickly measure the resistance before the circuit has had time to cool; but even this method of measurement can only lead to approximate results, and is of course quite inapplicable to the resistance of either an arc or an incandescent light. In such cases it is usual to measure the main current in ampères with an ammeter, and the difference of potential in volts with a voltmeter, between the two terminals of the lamp, since dividing the second reading, V, by the first, A, we have the ratio $\frac{V}{A}$ or R, the required resistance. And this method we have been in the habit of employing, not merely to measure the resistance of a lamp, but the resistance possessed by any part of the circuit while the current was flowing through it.

To avoid, however, always having to take two measurements, we devised some months ago an instrument which we have at length perfected, for measuring the ratio at one reading, and this instrument, called an "ohmmeter," differs from the power meter in that, while the latter measures the product, V A, the ohmmeter measures the ratio, $\frac{V}{A}$.

This instrument consists of two coils, one of thick and the other of fine wire. Both coils are fixed, and with their axes at right angles to one another, and the currents flowing through each act on the same needle. Through the thick coil the whole current, A, flows, and through the fine coil a shunt current which measures V, the difference



OHMMETER.

of potentials between the two ends of the part of the circuit the resistance of which it is required to measure; and the forces due to these two currents are at right angles to one another, hence the deflection of the needle may be made to measure $\frac{V}{A}$. By giving the proper mathematical shape to both the coils and to the needle, we have succeeded in obtaining the instrument seen in the accompanying figure, in which the deflections from zero are directly proportional to the values of $\frac{V}{A}$, that is, to the values of the resistances to be measured.

When the instrument is not in use, there is no directing force acting on the needle, and the pointer therefore remains anywhere. On allowing the main current to pass through the thick coil, by means of the outer and larger binding screws, the axis of the needle instantly places itself along the axis of the thick coil, and the pointer points to nought. If now wires be attached to each of the small binding screws belonging to the fine coil, and the other ends of these two wires be attached to the *same* point of the main circuit, the pointer still remains at nought, indicating that there is no resistance in the main circuit between the two points of attachment of the fine wires. If these wires be separated by, say, the field magnets of the dynamo, the pointer at once moves to a number indicating the resistance of the field magnets, &c. It will be seen, then, that the resistance of any part of the circuit can be measured at any time without interfering with the main current.

In actual practice, in fact, the ohmmeter is simply kept inserted in the main circuit anywhere, and when it is desired to measure the resistance of any part of the circuit, all that is necessary to be done is to connect, by means of two fine wires, the two ends of this part of the circuit to the two smaller binding screws of the ohmmeter.

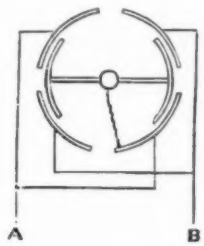
By the employment of the wheel and pinion, a deflection of about 320° of the pointer is obtainable, and on the present instrument a deflection of 60° corresponds with one ohm, so that measurement of resistances up to six ohms correct to 1-60th of an ohm can be accurately and quickly made. By altering the resistances of the two bobbins, the measured resistance corresponding with any particular deflection can be made anything we please.

One great use of the ohmmeter is that it enables us to dispense with resistance coils for experiments on dynamo machines. Any one who has used the resistance coils made for such purposes knows the difficulty of making coils of convenient size, whose resistances do not seriously alter with currents of 30 or 40 ampères. The coils cannot easily be made to cool fast enough to avoid the resistance seriously increasing with the current. We, on the other hand, use a bit of carbon, a bit of wet rope, or a pail of water, and measure with the ohmmeter the resistance of our extemporised resistance coil at the moment of making any experiment.

10. *Cylinder-spring Electrometer.*

For measuring differences of potential higher than 500 volts, the voltmeters already described are unsuitable, and recourse must be had to a portable modification of some form of Thomson's electrometer. We have devised two or three forms, one of which is seen on the table.

Two vertical pieces of metal, forming part of a cylindrical surface, are attached to a vertical arbor resting in jewelled bearings, and form the needle of the electrometer. This arbor is fixed to one end of an extremely fine spiral spring, the other end of which is fastened to the dial plate, which is itself electrically connected with one of the terminals, A. This spring serves two purposes—the one to give the needle directive force, the other for keeping up electric connection with the needle which turns inside four concentric vertical pieces of brass, which together nearly form a complete cylinder of a radius slightly larger than that of the needle, and which replaces the quadrant in the ordinary electrometer. These are electrically connected alternately in pairs, as shown in the small figure; and one pair is also connected with the needle through the very fine cylindrical spring, symbolically represented as a spiral line in the small figure. If, now, A and B be maintained at a difference of potential, E, a deflection, D, will be produced, which it may easily be shown is proportional to the square of E. One great advantage of this well-known method of connecting up the needle and quadrants of a Thomson's electrometer is, that although it does not produce as delicate an instrument as can be obtained by giving to the needle an independent charge, it enables the instrument to be used for measuring a rapidly-reversing electromotive force equally well as for



measuring a non-reversing electromotive force; whereas a fine wire galvanometer or dynamometer cannot be satisfactorily used for measuring even a small rapidly-reversing electromotive force, on account of the retardation arising from self-induction.

The advantage of the special modification above described of the quadrant electrometer is that it is portable; and from the needle having but a small moment of inertia, while at the same time it is everywhere very near the fixed attracting surfaces, the instrument may be made partly dead-beat, and at the same time sufficiently delicate to measure the large electromotive forces for which it has been designed.

If it is desired to measure the horse-power electrically expended in any portion, P Q, of a circuit conveying an alternate current, a measurement of the strength of the current may be made with a suitable ammeter, and a simultaneous measurement of the difference of potentials between P and Q with an electrometer. The following arrangement of the electrometer, however, enables the mean product of the alternate current and alternate difference of potentials between P and Q to be measured with the one instrument:—

Let it be desired to measure the energy electrically expended in a portion of the main circuit between two points, A and B, whose potentials are P and Q respectively. Connect these two points to the opposite fixed cylinders in the previous electrometer. Place in the main circuit, on either side of the portion, A B (say, on the A side), a resistance, R, having no self-induction, and let its farther end, C, of which the potential is S, be connected with the movable cylinder of the electrometer; then the deflection, D, measures the mean value of $(P - Q)\left(S - \frac{P+Q}{2}\right)$. Now connect the needle with A, instead of with C; then the deflection, D, measures the mean value of $(P - Q)^2$. Hence D — D′ measures the mean value of $(P - Q)(S - F)$, which is obviously R times the mean value of the energy expended on the portion of the circuit, A B.

A variation may be made in the second test, and which consists in

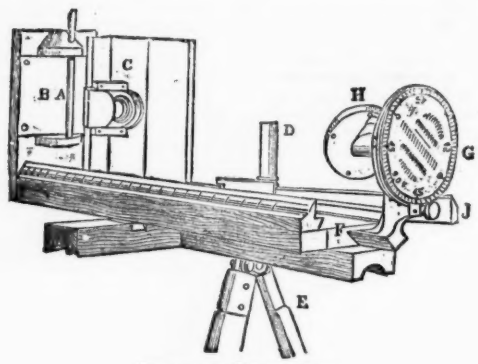
connecting the needle with a point, D, in the resistance coil, such that the resistance between D and A is $\frac{R}{2}$; in that case D″ will measure the mean value of $(P - Q)\left(\frac{S+P}{2} - \frac{P+Q}{2}\right)$, in which case $D - D''$ measures the mean value of $\left(\frac{(P-Q)(S-P)}{2}\right)$, or $\frac{R}{2}$ times the mean value of the energy expended.

12. *Dispersion Photometer.*

With this photometer measurements may be made in quite a small room of the illuminating power of the rays coming at any angle from even a powerful electric light. With the ordinary forms of photometer, the screen illuminated by the electric lamp must be placed so far away from the lamp that its brightness is the same as that of another screen, or of the other side of the same screen, illuminated by the standard candle. With the powerful electric lamps of the present day, a distance of 50 or 100 ft. is necessary, in order that a measurement may be made of the illuminating power by means of an ordinary photometer, and, in addition, it is very difficult to examine the light unless it comes from the lamp in a horizontal direction.

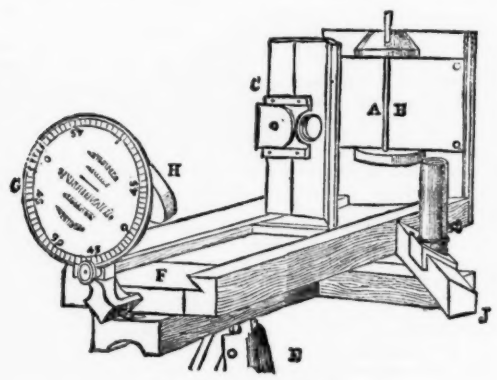
The principle of our dispersion photometer consists in the use of a concave lens to weaken the strength of the light (instead of placing the lamp far away from the screen), combined with the employment of a mirror turning round a horizontal axis, which makes an angle of 45° with its reflecting surface, in consequence of which rays coming at any angle from the lamp can be measured without the introduction of an error arising from the varying absorption at different angles of reflection; while at the same time a pointer attached to the mirror reads off on a graduated scale, G, attached to the instrument, the angle made with the horizontal by the beam of light under examination.

The instrument seen in the figures consists of a portable tripod stand, E, on which is screwed a small table, which is then carefully levelled.



DISPERSION PHOTOMETER.

The photometer is next placed on this table, and the pin at F, directly under the centre of the mirror, is passed through the base of the photometer into the hole in the table. The photometer, by turning round this pin, can, without producing any change in the distance of the centre of the mirror from the lamp, and therefore without changing the distance from the screen to the lamp, receive the small horizontal motion necessary for the adjustment for a new



DISPERSION PHOTOMETER.

inclination of the rays coming from the electric light. The divided circle, G, is clamped with the index at 0°, the electric lamp is lowered or raised till the illuminated disc formed on the screen of blotting paper, G, by the reflected light, passing afterwards through the lens, is in the middle of the paper screen. A little sliding shutter with a fine hole in its centre, seen in the figure, enables a very exact adjustment to be made; but in practice we find that we get sufficient accuracy without the use of the shutter. The instrument having been thus adjusted, the distance from the electric lamp to the centre of the mirror is next measured.

The candle in the holder, D, sliding on the graduated rod, J, having now been lighted, there will be seen cast on the screen of blotting-paper, B, two shadows, side by side of the black rod, A, placed in front of it, one being cast by the standard candle, the other by the beam from the electric light after reflection at the plane silvered mirror, H, and dispersed in passing through the concave lens in the sliding wooden frame, C. The lens is now moved backwards and forwards until the intensities of these two shadows are equal when seen through the sheet of red glass supplied with the instrument, and again adjusted until the shadows are of the same intensity when seen through the sheet of green glass. d, the axial distance of the lens from the screen, as shown by the pointer attached to the lens frame on the fixed graduated scale, as well as c, the distance of the candle, also shown by position of its pointer on its graduated scale, are now noted; whence if f is the focal length of the lens, and if D is the distance of the lamp from the paper screen (that is, the distance of the lamp from the mirror, plus the fixed distance of the mirror from the screen), and if L is the strength of the examined source of light in standard candles,

$$\sqrt{L} = \frac{D - d}{c}\left\{1 + d\left(\frac{1}{f} + \frac{1}{D - d}\right)\right\},$$

or

$$L = \frac{1}{c^2}\left\{D + \frac{d(D-d)}{f}\right\}^2.$$

We prefer to employ the formula; but as all the common instruments which have hitherto been manufactured have lenses whose focal length is four inches, we have prepared a table, a copy of which is sent out along with each instrument, in which the value of L is given for various values of D, d, and c. Using this table, it is necessary to have the lamp at either 60, 120, or 300 inches from the screen; the candle is either at 10, 14·14, or 20 inches from the screen; and the table is made out for every half-inch of the lens-scale. But inasmuch as we find that the improved arrangement of the mirror already referred to constitutes perhaps the most useful part of the instrument, and as the use of this improvement involves many alterations of D, Mr. Sennett, of the Kirby Street Engineering Works, Hatton Garden, the manufacturer, proposes in future not to furnish any table of the values of L unless specially asked for.

In these instruments we find that from 30 to 34 per cent. of the incident light at 45° is absorbed, whether this light is of ruby-red or signal-green colour, and practically none by the lens; so that we have the easy rough practical rule for all cases—add one-half to the measured intensity of light reflected. For more accurate working the exact absorption of the mirror of the particular instrument employed is used.

The intensity of the horizontal beam having been measured, the electric lamp is now raised or lowered and fixed in any position; a few seconds suffice to turn the mirror so that it sends its centre ray exactly through the centre of the lens. The distance from screen to mirror in this instrument being 22 inches, if δ is the distance from centre of mirror to vertical from lamp, and if θ is the angle of elevation, then

$$D = 22 + \delta \sec. \theta.$$

Using this value of D in the formula above, and adding one-half to the strength of the light to make up for absorption, or making the more accurate correction for the special instrument employed, the true intensity of the light in standard candles can be ascertained. In practice, if an electric light is moderately steady, ten measurements may be made, with some confidence in their accuracy, in two minutes; and the light may be measured in ten different positions, from an angle of depression of 60° to an angle of elevation of 60°, 100 observations being taken in less than half an hour.

We may mention one very important result we have been led to by the systematic employment of a photometer which can be used close to the electric light, and that is the large amount of absorption that occurs on certain days when the rays from strong electric lights, and especially the green rays, pass through the air, which appears to the eye perfectly clear. At first we were inclined to think the higher results for the candle-power of a lamp obtained with our dispersion photometer than those obtained with an ordinary distance photometer were due to some error in our photometer itself; but we have since ascertained that this is due to the absorption of the air, because we find that, if simultaneous measurements are made with ordinary Rumford's photometers, each without lens or mirror, placed at different distances from the lamp in the same azimuth and in the same horizontal plane, the nearer one gives, as a rule, the highest readings, and the difference is the greater the stronger the light, and is greater if the light be examined at each photometer with green glass. The importance of such experiments in connection with the penetrating power of the electric light must be obvious.

13. *Electric-light Calculator.*

Having had occasion to make a large number of calculations of the illuminating power of various electric lamps, the horse-power electrically given to them, and the "efficiency" or number of candles per horse-power produced, we have devised and had constructed a simple piece of apparatus by means of which all the necessary calculations can at once be made, and which, after being used to work out the results obtained from any one experiment, preserves, until it is again used, a record of all the numbers employed in the previous calculations—an arrangement which serves as a valuable check in preventing clerical errors. The apparatus consists of four concentric discs graduated logarithmically, after the manner of the slide rule. The observed distance of the electric light from the photometer screen is sought for on scale 1: opposite this is brought the observed distance of the candle read off on scale 2, and

the pointer shows at once the candle-power of the lamp. On scale 3 is read off the current in ampères passing through the lamp, and opposite this is brought the observed difference of potentials in volts between its terminals read off on scale 4, when the second pointer shows at once the horse-power electrically given to the lamp. Finally, the illuminating power as shown by the first pointer is brought opposite the horse-power, as shown by the second, when the number of candles per horse-power is at once read off.

14. *Coulombmeter.*

We have also, mainly for the purpose of experimenting on charging and discharging Faure's accumulators, arranged an apparatus which registers the total quantity of electricity that has passed through it in any previous given time—an apparatus, in fact, which acts for electricity as a gas meter acts for gas. This coulombmeter is simply a small magneto-electromotor placed as a shunt to the main circuit, and acted on by *fluid friction*, which forms the essence of the apparatus, since such fluid friction opposes a resisting force directly proportional to the velocity, while, on the other hand, the force causing motion is proportional to the current; hence the current flowing is proportional to the velocity, and the total quantity of electricity that flows in any time is proportional to the total number of revolutions made by the motor in that time, which are counted by an ordinary speed-counter attached to the revolving spindle. Hence the number of coulombs of electricity that have passed may be measured, by taking two readings of the counter, as easily as can the number of cubic feet of gas consumed by taking two readings of the gas meter.

This coulombmeter we have used for some time; but we have found this week that an instrument somewhat of this nature was patented some time back by Mr. Edison, although we are not aware that he has ever used it, or whether he realises the absolute necessity of the existence of a fluid friction. To him, however, we must yield up the priority of invention for this form of coulombmeter.

We have a strong current available, and we will now proceed to test experimentally all these various instruments which you see in the room before you, and which have been designed and constructed in each case to supply an actual need, which our experiments led us to see existed, for exact, portable, and moderately cheap measuring instruments for use in electric lighting and electric transmission of power.

GROVES'S DISCHARGE KEY.

THE discharge keys in general use perform three operations—charge, insulate, and discharge. Mr. Robert Sabine, however, to suit his own testing arrangement, introduced an additional lever and cam by which the three contacts are brought into metallic connection, thus short-circuiting the key. The design of such keys is of a mixed character, and, although made of high insulating material, they are not provided with any protection from light, air, and dampness, consequently they somewhat rapidly deteriorate and require careful preparation before use.

The key about to be described will perform the four operations above mentioned, and is made with protection for the contacts and insulation, especially the principal (cable) terminal, and the design is of a general character. Fig. 1 represents the external appearance. A is a brass case with glass cover, D, having a hole through which passes the cable terminal, C; there is a space between the glass cover and the terminal which is closed when not in use with an ebonite disc or washer which slides upon the terminal. This said terminal passes through a hole in the base and is prolonged under the ebonite slab to the frame, thus giving six inches of insulation, and it is protected from light and air. On

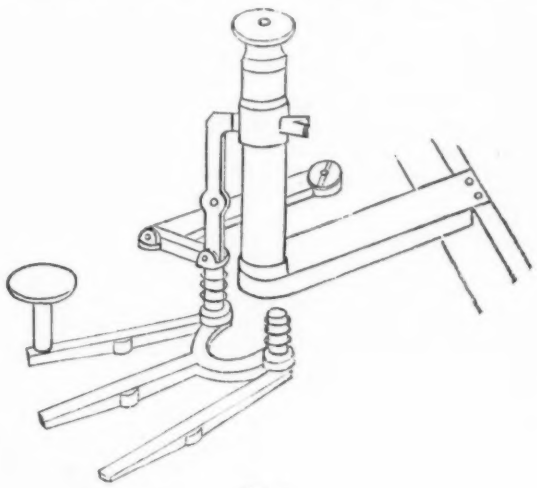


FIG. 2.

each side of the upper end of the cable terminal is fixed a V-shaped contact stud, into which the end of a crank lever is pressed, the pressure being given by a spiral spring when a lever connected with the studs is raised. The terminals, G and B, are well insulated, but they are not so important as the cable one.

Fig. 2 is a sketch of the working arrangement. One of the crank levers is left out to prevent confusion. The studs are arranged in a similar manner to those employed in Wheatstone's A B C instruments, consisting of pulleys and a chain; when one stud is depressed the one already down is raised, and only one can be pressed down at a time. The merits claimed for this key are certainty in its action and easiness of manipulation (it only necessitating the depression of one of the studs, S, to produce the result required), high insulation, and the protection of the contacts. A vessel of sulphuric acid can be placed in the case to absorb any moisture that may have got in.

The maker of this key is Mr. Groves, of 89, Bolsover Street, W., and he is doubtless well known to most of our readers as having formerly been the assistant of the late Sir Charles Wheatstone, for whom he carried out many of his most important experiments.

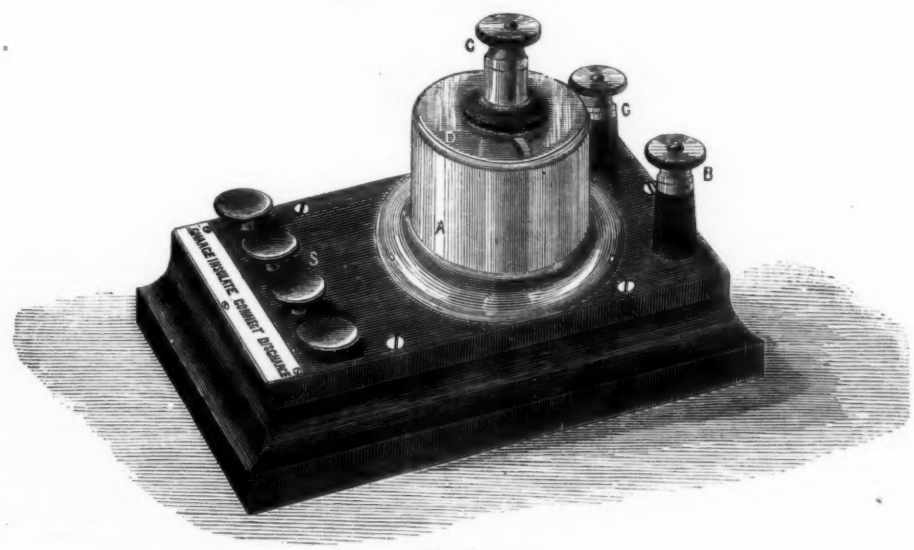
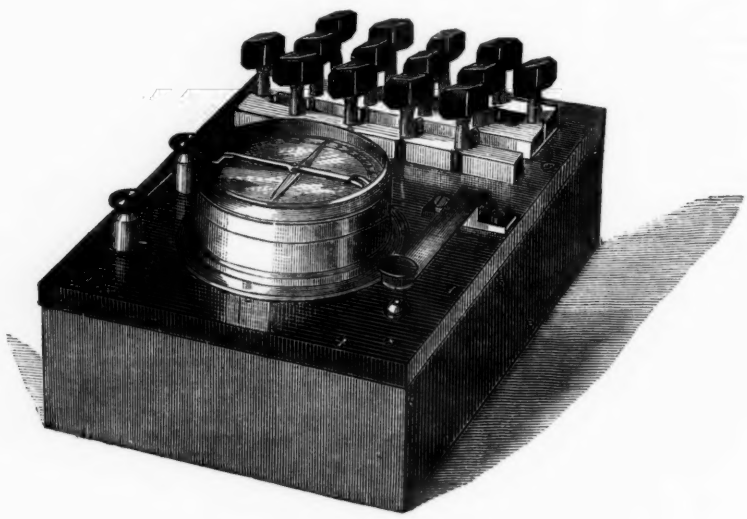


FIG. 1.

SIMMONS'S PORTABLE TESTING BOX.

WE have recently had an opportunity of examining and using one of these very useful and compact testing boxes for measuring resistances. That with which we have been operating is arranged to measure from 0·01 to 20 ohms. The resistances are made up as follows: ·01, ·02, ·02, ·05, ·1, ·1, ·2, ·5, 1, 1, 2, 5 and 10 ohms. There is also an "infinity" plug, so that the adjustable resistance may be broken.

The "Wheatstone bridge" method is not employed in this apparatus, and we need, therefore, scarcely inform our readers that the galvanometer is wound differentially. We believe that each side has a resistance of about 15 ohms. The battery consists of four small Leclanché elements of the medical type, connected up for quantity, and virtually forming one large cell. This is fixed in the interior of the box, and the various connecting wires are permanent and hidden from view. The wire or coil whose resistance is unknown is attached to the two binding screws, and the adjustable resistance unplugged, until no movement of the galvanometer needle is observed. A contact key is



arranged on the box for the purpose of putting the battery in circuit. The sensitiveness of this instrument is such that resistances can be easily measured to two places of decimals; and if greater accuracy be desired, it can be obtained, as is sometimes done with the "Wheatstone bridge" arrangement, by proportional deflections. For all practical purposes the second decimal place suffices, except in such an extreme case as measuring, for instance, the armature resistance of a large Edison dynamo-electric machine. Mr. Simmons, however, makes up the various resistances contained in his boxes for any particular requirements.

Mr. Simmons for several years took a prominent position in the business of Messrs. Elliott Brothers, and this fact alone is sufficient to guarantee excellence and accuracy of workmanship, together with an electrical knowledge of no common order. We should imagine that such an apparatus would be of great service to electric light engineers, especially to those members of the profession who are continually travelling about, installing the electric light in various towns. The veriest tyro can manipulate this instrument after its operation has once been explained, for electrical knowledge is not necessarily requisite. We can cordially recommend this testing box, and we do not doubt but that Mr. Simmons will find his compact combination sought after.

The illustration shows all that is necessary in order to understand the construction of the apparatus, and it is contained in a travelling case, 11 by 8 by 5½ inches.

THE BRITISH ASSOCIATION.

[*Specially reported for the* ELECTRICAL REVIEW.]

THE ELECTRO-MAGNETIC PRACTICAL SYSTEM OF UNITS.

[Paper read by Dr. C. W. SIEMENS, before Section A, Tuesday, 29th August, 1882.]

SINCE referring to the subject of electrical units in my presidential address, I have been requested by several members of this section to bring the matter again before you, to afford an opportunity for its fuller discussion. I have great pleasure in acceding to the request, as I am most anxious to hear the views of the members of this section on the several units which I ventured to add to the list decided on at the Paris Electrical Congress.

At this Congress, which was attended officially by the leading physicists of all civilised countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic or dynamical system developed by the British Association, also between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The Congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several Governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labour is utilised; only, instead of expressing electrical quantities directly in absolute measure, the Congress has embodied a consistent system, based on the ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereinafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the Ohm, Ampère, Volt, Coulomb, and Farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "Weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the Congress in order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

As Clausius has shown, the unit of pole in absolute measure must be multiplied by the factor 10^8, in order to make the Weber consistent with the practical system. With greater diffidence I would submit two other units, which, I think, would be of considerable service in practical work. Firstly, the unit connecting heat measurements with the electrical system. Hitherto the unit of heat has been taken variously as the heat required to raise a pound of water at the freezing point through 1° F. or C., or, again, the heat necessary to raise a kilogramme of water 1° C. The inconvenience of such a unit so entirely arbitrary is sufficiently apparent to justify the introduction of one based on the electro-magnetic system, *i.e.*, heat generated in a second by the current of an Ampère flowing through the resistance of one Ohm. In absolute measure its value is 10^7 C.G.S. units, and assuming Joule's equivalent as 42,000,000, it is the heat necessary to raise ·238 grammes of water 1° C., or approximately 1-1000th

of the arbitrary unit of 1 lb. of water raised 1° C. Such a heat unit might with great propriety be called the Joule.

The last unit I should suggest adding to the list is that of power. The power conveyed by a current of an Ampère through the difference of potential of a Volt is the unit consistent with the practical system. It might be appropriately called a Watt, in honour of that master mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A Watt then expresses the rate of an Ampère multiplied by a volt, whilst a horse-power is 746 Watts, and a cheval de vapeur 735. Accepting the Joule, the Watt can be briefly defined as a Joule per second.

The definition of the Joule which I have given leads, no doubt, to a somewhat small—perhaps inconveniently small—value to heat measurements; but the advantages of consistency with the other units appear to me to outweigh any inconvenience there may be in this respect. The complete system of electro-magnetic units would then be:—

(1)	Weber,	unit of magnetic quantity	= 10	C.G.S. Units.
(2)	Ohm	,, resistance	= 10^9	,,
(3)	Volt	,, electromotive force	= 10^8	,,
(4)	Ampère	,, current	= 10^{-1}	,,
(5)	Coulomb	,, quantity	= 10^{-1}	,,
(6)	Joule	,, heat or work	= 10^7	,,
(7)	Watt	,, power	= 10^7	,,
(8)	Farad	,, capacity	= 10^{-9}	,,

At the Paris Congress Sir W. Thomson suggested that the unit of magnetic field would be a useful addition, and pointed out that it would be proper to attach to it the name of Gauss, who first theoretically and practically reduced observations of terrestrial magnetism to absolute measure. It is a point for discussion as to what would be the definition of the Gauss, to keep it consistent with the other units. Defining it in the way perhaps most obvious, as the strength of field produced by a Weber at the distance of one centimetre, its value would be 10^8 C.G.S. units, but this is certainly inconveniently large, consequently I have considered it advisable to omit it from the list, and leave it in the form originally proposed by Sir W. Thomson, as the absolute unit of magnetic field.

(To be continued.)

NOTES ON ATMOSPHERIC ELECTRICITY.

[Paper read by C. MICHIE SMITH, B.Sc., F.R.S.E., Professor of Physical Science in the Madras Christian College, at the Meeting of Section A, on Wednesday, August 30th, 1882.]

BEFORE leaving for India in the end of 1876, it occurred to me that as almost nothing seemed to be known about atmospheric electricity in the tropics, it would be well if I could take with me the apparatus necessary for making observations on it. I accordingly communicated with Sir W. Thomson, who kindly obtained for me a grant from the British Association for a portable electrometer. This instrument I took with me, and the following are the results of the observations made with it. During the voyage a number of observations were made, but of those only two sets were of any special interest. The first of these was made in the Suez Canal, on December 22nd. At 8 a.m., at noon, and again at 8 p.m., the readings showed a negative electrification, of from three to eight divisions of the scale, the weather being entered as "fine and bright," and the wind as "S., very light," "E. by S., light breeze," "E.S.E., light," respectively; while readings taken at 1.30 p.m. and 7.30 p.m., gave a positive electrification of eight divisions on each occasion. This has considerable interest in connection with some observations made at Madras. The other set was made in the Red Sea during a rather violent squall. In this case the readings varied very rapidly from strong + to strong —, readings 1½ hours before having been + 18 divisions. The variations took place so rapidly that no quantitative observations could be made, and in a few minutes, when the squall had passed over, the readings were found to be much as before + 17 divisions. In Madras, a series of observations were made, extending from 17th January to 4th March, 1877. These were made at 8.30 a.m. and 6 p.m., and showed a wonderfully steady state of electrification, varying from a maximum of + 53 to + 19, with an average of + 33. The morning and evening readings usually agreed very closely. In every case the electrification was positive, and the weather very fine without any rain. During this time the electrometer had to be recharged every two or three days, an operation which, though very simple in this climate, is by no means so simple in a climate so moist as that of Madras. After a time I found it impossible to continue the observations at all, and sent the instrument home to see if it could be in any way modified so as to suit the climate. On its return, after a long delay, I found it leaked as badly as before, and so rendered observations almost impossible. The reason is doubtless to be found in the circumstance that the air of Madras is not only moist, but is also very full of small particles of salt, which are constantly being carried from the surf by the sea breeze. The glass of the jar soon gets coated with these particles, and no amount of simple drying will make the insulation good. That the fault did not lie in the jar itself I have tested since my return to this country, for I find that here the leakage is less than 1·5 per cent. per diem, while in Madras it was often over 30 per cent. per diem.

On account of these difficulties I was unable to make any long series of observations, but in July of 1881, I made a few that were specially interesting as being the only ones in which I have observed negative electrification in Madras, except during the thunderstorms. The observations were as follows:—

July.	p.m.			Reading.
5	1	Strong land wind.	Temp. 94° F.	—74
6	,,	,,	,,	—16
7	,,	,,	,,	0
,,	2·20	,,	,,	—15

In each case local showers within three or four hours. These observations are, of course, too few to form any theory upon, but those acquainted with the peculiar sensations produced by the land wind in Madras, will feel that the point is worth investigation, and I hope on my return to Madras to be able to take with me improved apparatus with which to continue the observations.

ON SECONDARY BATTERIES, WITH SPECIAL REFERENCE TO LOCAL ACTION.

[Paper read by Dr. GLADSTONE, F.R.S., before Section A, Friday, August 25th.]

THE high hopes that were originally entertained of the Planté battery and its various modifications have scarcely been realised as yet, and one main cause of this is to the extent to which their efficiency is apt to be reduced by local action. The positive element is always metallic lead, the negative element peroxide of lead, and the binary liquid dilute sulphuric acid. Now the peroxide of lead, which constitutes the negative plate, is itself supported by a sheet of lead, and both are immersed in acid. Voltaic action necessarily takes place, therefore, between the elements of which this plate is composed; the lead is converted into sulphate of lead, while the peroxide is reduced to protoxide, which immediately combines with some of the excess of acid to form sulphate of lead and water. As however this insoluble salt is produced on the surface of the metallic sheet, and of the peroxide crystals, a barrier to further action is speedily formed; but, as the amount of force which can be obtained from one of these cells depends upon the amount of peroxide that is capable of being reduced, the value of the cell is *pro tanto* diminished. This local action may have taken place to a great extent without its being recognised. On joining the negative and positive plates the current that instantly ensues is of almost the full strength, and the electromotive force is still 2·0 volts, or thereabouts. It is only when the cell has been allowed nearly to exhaust itself that the loss of power through the destruction of the peroxide makes itself evident by the smaller amount of work done.

This local action is not stopped, though it is probably diminished, by the discharge taking place between the negative plate and the positive one. It takes place also during the formation of the cell, as is evidenced by an absorption of oxygen greater than would be required merely for the oxidation of the minium used in Faure's process, and by the continuous absorption of a small quantity of oxygen for days after the main action is complete.

This defect of the existing secondary batteries is probably to be overcome by some modification of the elements employed in their construction.

(To be continued.)

ON SOME APPARATUS FOR USE IN CONNECTION WITH ELECTRIC LIGHT MEASUREMENT.

[Paper by ROBERT SABINE, C.E. Read before Section G, Aug. 29th.]

HAVING occasionally to make measurements requiring some degree of exactness of the electrical and photometric values of electric light systems, in reference to the power expended in maintaining them, I had for some time difficulty in finding apparatus specially adapted for this work, the electrical instruments which were suitable for continuous current systems being, as a rule, unsuitable for alternate currents. I was therefore induced to design some apparatus for my own use, which I have found convenient and sufficiently exact for practical purposes.

I. THE PHOTOMETER.

The absorption of light when passing through translucent media has hitherto been almost entirely unemployed for photometric purposes. Lampadius, it is true, suggested the reduction of any ordinary light to its vanishing point by means of thin sheets of horn, assuming that this vanishing-point might be taken as a fixed unit of intensity—a method which De Limency and Secretan proposed to modify by employing sheets of paper instead of horn—and Count Xavier de Maistre and Quetelet suggested the employment of wedges of blue glass for purposes of stellar photometry. But in neither instance was anything approaching to a practical photometer produced.

The photometer which I am about to describe is based upon the partial equalisation of any two lights under comparison, by interposing in the path of the rays of each light a sufficient thickness of absorbing material, the final adjustment being made by a slight alteration of the relative distances of the lights from the photometer.

Instead of comparing the lights directly with each other, I find that much better results are obtained by comparing them singly with a third light, which is constant.

This constant light I obtain by allowing the rays from a small portion of the bright part of a paraffine flame to pass through suitable diaphragms; the advantage of this method being that so long as the diaphragms are not too large, any trifling irregularity in the paraffine flame, through burning higher or lower, does not affect the small portion of the bright part which is employed, and therefore the utilised light is practically as nearly constant as possible. The form of apparatus which I use is shown in section in fig. 1, in which the photometer is placed, for convenience of illustration, vertically, as if measuring a light immediately above it. The graduated scale, a, a^1, upon which the photometer travels, turns upon a centre carried by a stand (not shown in the drawing), and can be elevated or depressed to any desired angle. The photometer consists of a square brass box, d, d, on one side of which is a draw-tube and eye-piece with

lens, g; and on the other side a tube, f, carrying a collar by which the paraffine lamp, b, b, is supported, and may be kept in a vertical position at whatever angle the scale may be directed. The chimney of the paraffine lamp is of copper, and opposite to the bright part of the flame, is provided with a tube, e, in which are a thin pane of glass and two diaphragms, and at the back another tube, e^1, in which a dark glass is fitted for observing, from time to time, the flame, to ascertain that it is burning in the proper position.

At p_1 is a thin sheet of translucent material, part of its inner surface being observed direct by the eye at g.

The light to be measured is placed at a distance (under three feet if possible) beyond the end, a, of the scale, so that its rays fall upon the face of a thickness of translucent material, p, inserted in a suitable guide at the side of the photometer, its inner surface being observed

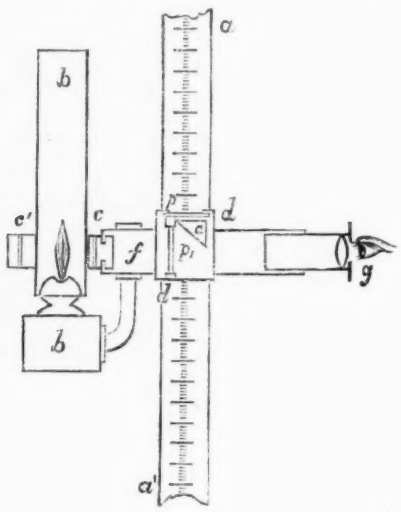


FIG. 1.

by the eye at g, reflected by the prism, e, which occupies half of the field of view. The thickness of the interposed translucent material, p, is adjusted until the illuminations of the two halves of the field of view are as nearly equal as this adjustment allows; then the distance between the light to be measured and the face of p is adjusted by causing the photometer, which is mounted on rollers, to travel on the scale until the two halves of the field of view are equally illuminated.

The illustration shows the photometer directed vertically upwards; but as the lamp may be turned with the collar which supports it, the scale may be placed horizontally or inclined at any desired angle upwards or downwards. In order to lessen the effect upon the eye of slight differences of colour between the lights to be compared, there are inserted just at the top and bottom of the line in which the two halves of the field of view meet, small strips of highly coloured glass. The effect of the presence of these, when I am observing, is to render the eye partly unconscious of small differences of tint of the middle portions of the field of view, without reducing its sensitiveness for appreciating the balance of illuminating effect.

The comparison with the horizontal light of a standard candle is done by placing the photometer horizontally and putting the candle at the end, a, of the scale, reducing at the same time the thickness of the translucent material, p, until a balance is nearly obtained, and finally adjusting by sliding the photometer along the scale.

The intensity of the light which penetrates from the paraffine lamp to the inner surface of the translucent sheet, p_1, and which is the constant of comparison, we will call λ. We may assume that of the light which falls upon the surface, p, the fraction which is scattered and reflected bears to it a constant relation, r.

Let L be the illuminating power of the measured light in the direction of the photometer, n the thickness of absorbing material, and D the distance of the source of light from p. Then the light which reaches the surface of p when a balance is obtained will be:—

$$\lambda = \frac{(1-r)\,\mathrm{L}\,m^n}{\mathrm{D}^2},$$

m being the co-efficient of translucency of the absorbent body, p; that is to say, the intensity of light which succeeds in reaching the inner surface of a unit thickness of p, when a unit intensity of light enters the outer surface.

Similarly, for the standard candle, the illuminating power of which is l, its distance, d, and the interposed thick of the same translucent material, n_1:—

$$\lambda = \frac{(1-r)\,l\,m^{n_1}}{d^2},$$

the relation of these two lights is, therefore:—

$$\frac{\mathrm{L}}{l} = \left(\frac{\mathrm{D}}{d}\right)^2 m^{n_1-n}$$

it being assumed that the light of the paraffine lamp has remained constant during the two observations, and that the atmosphere has not acted as an absorbent.

The co-efficient of translucency of the interposed absorbent material must, of course, be very carefully determined, because upon the value of this co-efficient being exactly known depends the accuracy of the results obtained as much as upon the accuracy of the final adjustment of distance.

This co-efficient I determine by employing a strong steady light, and taking observations of distance first with one, then several (say, n) thicknesses of the material.

If the observed distance with one thickness is d_1, and that with n thicknesses is d_n:—

$$m = \left(\frac{d_n}{d_1}\right)^{\frac{2}{n-1}}.$$

I find that the readiest way is to take alternately the distances with one and three thicknesses, because then

$$m = \frac{d_3}{d_1}$$

a simple relation which saves calculation.

The comparison of one with two thicknesses was found to be objectionable, as any error of observation was exaggerated, whereas when more than three were taken for the co-efficient the illumination of the field became weakened, and the observations were less accurate.

It is not necessary that the translucent body at p_1 should be either of the same quality, tint, or thickness, as that used at p, as it is simply intended to provide a constantly illuminated surface for comparison; but the thicknesses of the material used at p must be carefully selected, and must be as uniform as the eye is capable of detecting. The material which I have found to be most convenient for use as an absorbent, consists of thin plain photographic paper, which is very uniform in texture, and is easily procurable.

In an earlier form of this photometer, the comparison was made direct with a standard candle, by enclosing the latter in a candle-holder consisting of a closely-fitting tube, furnished with a spring, which pressed the candle up against a top rim, and maintained it at a constant level in a suitable dark lanthorn.

It was found, however, that a candle so circumstanced always gave a reduced light, and that other lights compared with it appeared to be exaggerated in photometric value; moreover, the difference of colour between the light of a candle and that of most electric arc lamps, is very striking, while the colour of a paraffine flame is between the two, and the difference, therefore, between it and either the candle or electric light is less embarrassing.

When it is desired to employ Schwendler's method of observing the illuminated surfaces through coloured glasses, I place them before the eye-piece, g.

II. THE CURRENT DYNAMOMETER.

The current dynamometer is constructed to be equally applicable to continuous and alternate currents.

It consists of two circular flat coils of thick copper, a and b, as shown in outline in fig. 2.

One of the coils, a, is carried on a beam, together with a counter-weight, by a bifilar suspension. This suspension is done by a thin silk thread, the two ends of which are fixed to a torsion-head at d,

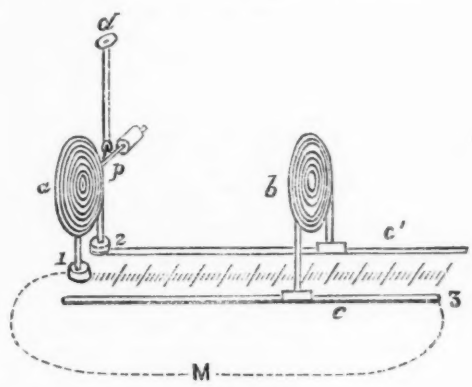


FIG. 2.

its middle portion passing under a small friction pulley, p, attached to the beam. By this means the strain upon both sides of the bifilar thread is equal. The ends of the movable coil, a, are amalgamated, and dip into two suitable mercury cups (1 and 2). In the position of rest, the torsion-head of the bifilar suspension is turned so that the plane of the coil, a, forms an angle of 5° to 10°, with the plane of the coil, b; its angular position being observed by a mirror attached to the suspended coil, which projects a spot of light upon a scale placed at a constant distance. The second flat coil, b, is mounted upon grooved copper feet, which slide upon two copper rails, c, c^1, keeping coil b at right angles to the rails and facing coil a, but at distances which may be readily varied.

The dynamometer is inserted in the circuit whose current is to be measured, between terminals connected with the points 1 and 3. The current from M enters the system at the terminal connected with the mercury cup (1), circulates (right-handed) through the suspended coil, a, which it leaves by the mercury cup (2), passes along the rail, c^1, to the sliding coil, b, in which it circulates (left-handed), passes to the rail, c, and so back to the circuit.

The repulsion which takes place between the coils, results, of course, in the deflection of the suspended coil to a greater or less degree, according to the strength of the current and the distance

between the coils. If this deflection is insufficient to place the coil, *a*, parallel to coil, *b*, the latter is slid along the rails nearer to *a*; but if the repulsion cause *a* to be deflected beyond its parallel position, coil *b* is drawn back until the light point settles to the zero of the scale.

The sluggishness of the mercury in the cups is utilised to check any continued oscillation.

The scale of the instrument is placed between the rails. It was calibrated by comparison with a tangent galvanometer, the position of the sliding coil, *b*, when the parallel position of the suspended coil was obtained, being marked for each ampère of current; and it was found that, beyond one ampère, the distance was practically proportional to the current; but below one ampère this proportion did not obtain, probably due to want of symmetry in the coils themselves.

As the deflection of the suspended coil is always the same, the repelling force acting upon it is constant; and if this force is directly proportional to the square of the current, and inversely to the square of the distance between the coils, it would follow that the current and distance should be directly proportional to each other.

The resistance to deflection of the suspended coil must, of course, be kept as constant as possible. This I have attempted by using unspun silk for the bifilar suspension, and putting the threads at a sufficient distance apart to cause the resistance to deflection to be due more to the lifting of the coil than to the torsion proper of the threads.

By making the current go through the two coils in derived circuit instead of in series, the sensitiveness becomes reduced to half; the range of the scale being proportionately increased. For very strong currents the range of the scale can be increased to any extent by properly arranged shunts.

When measuring very strong currents the disturbing effect of the earth's magnetism has to be considered. In order to allow for this, before making an observation I place a coil of wire of the same resistance as one of the working coils, but double-wound, upon the rails in place of *b*. This dummy coil has no deflecting effect upon the suspended coil, but renders the current moving through it the same as when *b* is in its place. When this is done the effect of the earth's magnetism is to cause a slight deflection of the suspended coil from its position of rest, to which it is then re-adjusted by turning the torsion-head.

So far I have found this method to be convenient, although the apparatus I use is home-made, it has the advantage of being strictly a zero method, and the instrument is not encumbered with any table for the reduction of observations.

III. The Potential Dynamometer and Resistance Measurer Combined.

This instrument is designed to fulfil a double duty, and as a potential dynamometer is equally available for continuous and for alternate currents.

It consists of two circular coils of moderately fine copper wire, one of which is held by a bifilar wire suspension inside the other, as in Weber's well-known dynamometer. When required, however, to be used as a galvanometer, the suspended coil can be readily removed and replaced by a magnet needle.

When used as a dynamometer with a potential-difference of one Daniell between the terminals, the suspended coil is deflected to between 100 and 150 divisions of a reflected light point falling upon a scale at a distance of 100 centimetres. This reading, which remains very constant, can, however, be adjusted for a greater or less degree of sensitiveness by altering the distance apart of the bifilar suspending wires.

The reading with one Daniell potential-difference is the constant of the dynamometer, and is obtained by inserting between the terminals a Daniell cell having a resistance sufficiently small that it may be neglected without appreciable error.

When any greater potential-difference is to be measured, an adjustable resistance is inserted in the circuit in order to reduce the current (and deflection) to the same value as the constant. For instance, if a potential-difference, *x*, of an electric arc is to be measured, the terminals of the lamp, or connections from the carbons, are inserted, with an adjustable resistance which is gradually reduced to *r*, so as to reproduce the constant deflection of the light-point. The constant current is then represented by two equations:—

$$c = \frac{e}{\rho}$$

ρ being the resistance of the dynamometer wires, and *e*, volts, the electromotive force of the Daniell, and:—

$$c = \frac{x}{r + \rho},$$

assuming that the resistance of the arc may be neglected, as it is very small in comparison with $r + \rho$.

The electromotive force of the arc is therefore:—

$$x = e\left(\frac{r}{\rho} + 1\right) \text{ volts.}$$

The effect of the earth's magnetism upon the suspended coil is, of course, entirely eliminated, the current being the same in each observation.

The resistance box, which I use in connection with this dynamometer, is constructed with adjustable resistances between one and 100,000 ohms, and has in addition the usual proportion-coils of a Wheatstone bridge.

When it is required to measure the wire resistance of a circuit, this resistance box is employed as a Wheatstone bridge. The suspended coil of the dynamometer is removed, and a magnet-needle inserted in the centre of the stationary coil, so as to readily provide a galvanometer which is sufficiently sensitive for measuring small resistances with the aid of the constant Daniell cell, thus avoiding the necessity of providing separate instruments for this purpose.

IV. The Mean Pressure-Indicator.

The determination of the horse-power performed by the steam-engine is usually made by taking diagrams with a Richard's modification of Watt's indicator. There are, however, some objections to the use of this instrument for this purpose, arising from the necessity of special fittings, besides the fact that these diagrams, obtained at considerable trouble, give more information than is wanted for the object in view.

The horse-power is calculated only from the mean pressure, which I have endeavoured to arrive at in a more simple way. Instead of taking indicator-diagrams, I have obtained very good results with a simple Bourdon pressure-gauge, so arranged that the mean pressure at either end of the cylinder can be read off at once, and the horse-power obtained at any moment with very little trouble.

For this purpose I attach to each end of the cylinder a pressure gauge, the pipe leading to which is throttled sufficiently to allow only of a small entry and exit of steam at each stroke. This throttling may be carried to such an extent that the pointer of the gauge rises comparatively slowly to the mean pressure, above and below which it makes small oscillations.

In the arrangement of the gauge, the attachment to the blow-off cock of the cylinder is conveniently made by a short length of thick india-rubber tubing, strengthened by a double serving of tape, and lashed. Between this and the gauge, I insert a tube of brass containing, in a socket coupling, a screw plug, through which a small hole is bored. Every precaution has, of course, to be taken to prevent condensation of steam in the throttle or in its immediate neighbourhood. For this purpose I keep the throttle-tube at a temperature considerably above the temperature of the steam by placing the flame of a lamp underneath it. Between the throttle and the pressure gauge is a small blow-off cock. Before observing the mean pressure this cock is opened, and steam blown through. It is then closed, and the pointer of the gauge rises by a series of jerks up to the mean pressure, about which it oscillates through a small arc, the mean point being easily observed.

ON A NEW ARC ELECTRIC LAMP.

By W. H. Preece, F.R.S.

[Read before Section G of British Association.]

Electric lamps on the arc principle are as numerous as the trees in the forest and it is somewhat fresh to come upon something that is novel. In these lamps the carbons are consumed as the current flows, and it is the variation in that consumption which occasions the flickering and irregularity of the light that is so irritating to the eyes. Special mechanical contrivances or regulators have to be used to compensate for this destruction of the carbons, as in the Siemens and Brush type, or else refractory materials have to be combined with the carbons, as in the Jablochkoff candle and in the Lampe-Soleil. The steadiness of the light depends upon the regularity with which the carbons are moved towards each other as they are consumed, so as to maintain the electric resistance a constant quantity. Each lamp must have a certain elasticity of regulation of its own to prevent

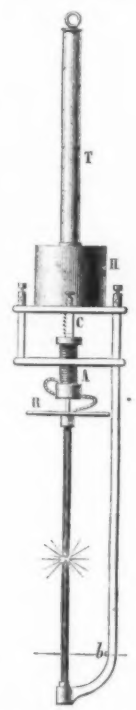


Fig. 1.—Abdank's Arc Lamp.

irregularities from the variable materials of carbon used, and from variations in the current itself and in the machinery.

In all the electric lamps, except the Brockie, the regulator is in the lamp itself. In the Brockie system the regulation is automatic, and is made at certain rapid intervals by the motor engine. This causes a periodic blinking that is detrimental to this lamp for internal illumination.

M. Abdank, the inventor of the system which I have the pleasure of bringing before the Section, separates his regulator from his lamp. The regulator may be fixed anywhere within easy inspection and manipulation, and away from disturbing influence in the lamp. The lamp can be fixed in any inaccessible place.

The Lamp (figs. 1, 2, 3).

The bottom or negative carbon is fixed, but the top or positive carbon is movable in a vertical line. It is screwed at the point, C, to a brass rod, T (fig. 2), which moves freely inside the tubular core of

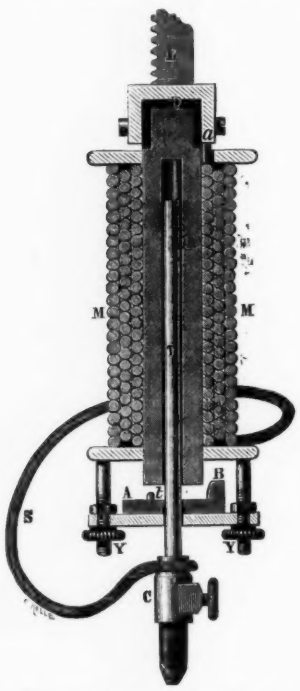


FIG. 2.—ABDANK'S ARC LAMP.

an electro-magnet, K. This rod is clutched and lifted by the soft iron armature, A, B, when a current passes through the coil, M, M. The mass of the iron in the armature is distributed so that the greater portion is at one end, B, much nearer the pole than the other end, hence this portion is attracted first, the armature assumes an inclined position maintained by a brass button, *t*, which prevents any adhesion between the armature and the core of the electro-magnet. The electric connection between the carbon and the coil of the electro-magnet is maintained by the flexible wire, S.

The electro-magnet, A (fig. 1), is fixed to a long and heavy rack, C, which falls by its own weight and by the weight of the electro-magnet and carbon fixed to it. The length of the rack is equal to the length of the two carbons. The fall of the rack is controlled by a friction-brake, B (fig. 3), which acts upon the last of a train of three wheels

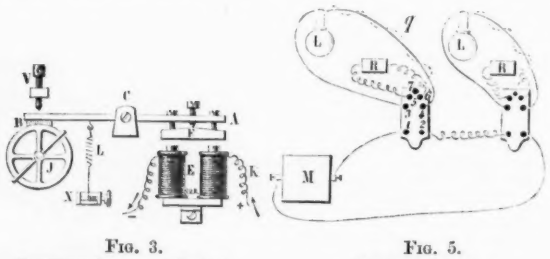


FIG. 3.
SHOWING FRICTION BRAKE.

FIG. 5.
LAMPS IN SERIES.

put in motion by the above weight. The brake, B, is fixed at one end of a lever, B A, the other end carrying an easily-adjusted soft iron armature, F, by three screws. This armature is attracted by the electro-magnet, E (whose resistance is 1,200 ohms), whenever a current circulates through it. The length of play is regulated by the screw, V. The spring, L, applies tension to the brake.

The Regulator.

This consists of a balance and cut-off. The balance (figs. 4 and 6) is made with two solenoids, S, S', whose relative distance is adjustable. S conveys the main current, and is wound with thick wire, having practically no resistance, and S' is traversed by a shunt current and is wound with fine wire, having a resistance of 600 ohms. In the axes of these two coils a small and light iron tube (2 mm. diameter and 60 mm. length) freely moves in a vertical line between two guides. When magnetised, it has one pole in the middle and the other at each end. The upward motion is controlled by the spring, N T. This spring rests upon the screw, H, with which it makes contact by platinum electrodes. This contact is broken whenever the little iron rod strikes the spring, N T.

The positive lead from the dynamo is attached to the terminal, B, then passed through the coil, S, to the terminal, B', whence it proceeds to the lamp. The negative lead is attached to terminal, A, and thence to the lamp.

The shunt which passes through the fine coil, S, commences at the

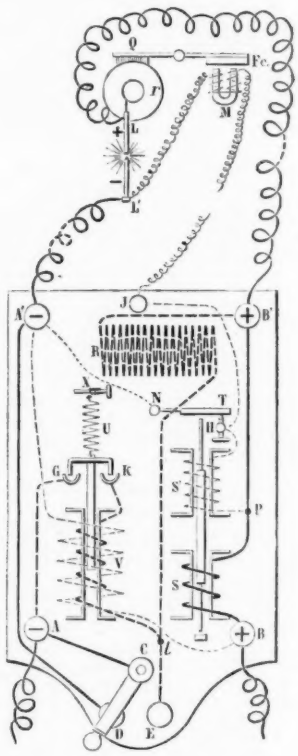


FIG. 4.—ABDANK'S ARC LAMP. THE BALANCE AND CUT-OFF.

point, P; the other end is fixed to the screw, H, whence it has two paths, the one offering no resistance through the spring, T N, to the upper negative terminal, A', the other through the terminal, J, to the electro-magnet of the brake, M, and thence to the negative terminal of the lamp, L'.

The Cut-off.

The last part of the apparatus to be described is the "cut-off," which is used when there are several lamps in series. It is brought into play by the switch, C D, which can be placed at E or D. When it is at E, the negative terminal, A, is in communication with the positive terminal, B, through the resistance, R, which equals the resistance of the lamp, which is therefore out of circuit. When it is at D, the cut-off acts automatically to do the same thing when required. This is done by a solenoid, V, which has two coils: the one of thick wire offering no resistance, and the other of 2,000 ohms resistance. The fine wire connects the terminals, A and B. The solenoid has a movable soft iron core suspended by the spring, U. It has a cross-piece of iron which can dip into two mercury cups, G and K, when the core is sucked into the solenoid. When this is the case, which happens when any accident occurs to the lamp, the terminal, A, is placed in connection with the terminal, B, through the thick wire of V and the resistance, R, in the same way as it was done by the switch, C D.

Electrical arrangement.

The mode in which several lamps are connected up in series is shown by fig. 5. The lead, +, is connected to B of the balance; it then passes to the lamp, L, returning to the balance and then proceeds to each other lamp, returning finally to the negative pole of the machine. When the current enters the balance it passes through the coil, S, magnetising the iron core and drawing it downwards. It then passes to the lamp, L L', through the carbons, then returns to the balance and proceeds back to the negative terminal of the machine. A small portion of the current is shunted off at the point, P, passing through the coil, S', through the contact spring, T N, to the terminal, A', and drawing the iron core in opposition to S. The carbons are in contact, but in passing through the lamp the current magnetises electro-magnet, M (fig. 2), which attracts the armature, A B, that bites

and lifts up the rod, T, with the upper carbon a definite and fixed distance that is easily regulated by the screws, Y Y. The arc, then, is formed, and will continue to burn steadily as long as the current remains constant. But the instant the current falls, due to the increased resistance of the arc, a greater proportion passes through the shunt, s′ (fig. 4), increasing its magnetic moment on the iron core, while that of S is diminishing. The result is that a moment arrives when equilibrium is destroyed, the iron rod strikes smartly and sharply upon the spring, N T, contact between T and H is broken, and the current passes through the electro-magnet of the brake in the lamp. The brake is released for an instant, the carbons approach each other, but the same rupture of contact introduces in the shunt a new method of considerable magnitude—viz., 1,200 ohms—that of the electro-magnet of the brake. Then the strength of the shunt diminishes considerably, and the solenoid, G, recovers briskly its drawing power upon the rod and contact is restored. The carbons approach during these periods only about ·01 to ·02 millimetres; if this is not sufficient to restore equilibrium it is repeated continually till equilibrium is obtained; the result is that the carbon is continually falling by a motion invisible to the eye, but sufficient to provide for the consumption of the carbons.

The contact between N T and H is never completely broken; the sparks are very feeble and the contacts do not oxidise. The resistances

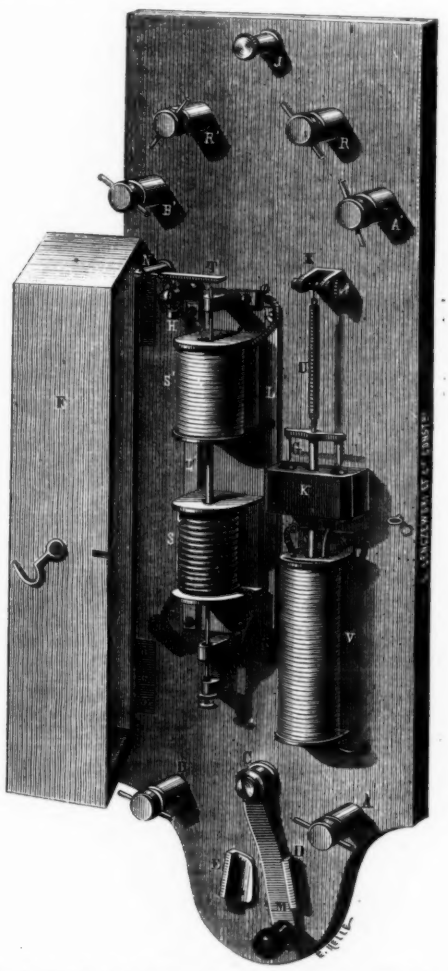


FIG. 6.—ABDANK'S ARC LAMP. PLAN OF BALANCE AND CUT-OFF.

inserted are so considerable that heating cannot occur, while the portion of the current abstracted for the control is so small that it may be neglected. The balance acts precisely like the key of a Morse machine, and the brake precisely like the sounder receiver so well known in telegraphy. It emits the same kind of sound and acts automatically like a skilled and faithful telegraphist. This regulation by very small and short successive steps offers several advantages. 1st. It is imperceptible to the eye. 2nd. It does not affect the main current. 3rd. Any sudden instantaneous variation of the main current does not allow a too near approach of the carbon points.

Let now an accident occur, for instance, a carbon is broken. At once the automatic cut-off acts, the current passes through the resistance, R, instead of passing through the lamp. The current through the fine coil is suddenly increased, the rod is drawn in, contact is made at G and K, and the current is sent through the resistance, R. As soon as contact is again made by the carbons the current in the coil, S, is increased, that in V diminished, and the antagonistic spring, U, breaks the contact at G and K. The rupture of the light is almost invisible, because the relighting is so brisk and sharp. I have seen this lamp in action, and its constancy and steadiness leaves nothing to be desired.

REPORT OF THE COMMITTEE ON ELECTRICAL STANDARDS.

[By LORD RAYLEIGH. At Section A, Tuesday, August 29, 1882.]

IN this matter I am only the mouthpiece of the committee. I have had very little to do with the work of which I am now to give an account. Almost the only matter in which progress has been made has been in experiments upon the effect of annealing upon electrical resistance of various wires of various metals, and in particular upon the temperature co-efficients, *i.e.*, the change which the resistance of the wire undergoes when the temperature is altered. These experiments have led to rather unexpected results, in the direction of showing that these effects are so much greater than is generally supposed, and that therefore there is greater difficulty than is usually thought of in the way of obtaining thoroughly satisfactory resistance standards. The following are some examples of the results obtained. In a wire of German silver, drawn so as to be extremely hard and brittle, the percentage of variation of resistance for one degree was ·0296. After annealing, the percentage of variation for the same wire was ·0421, showing a very large increase. In the case of steel, as might have been expected, the results are even more marked. For a steel wire, thoroughly hardened and tempered in paraffine wax, at a temperature of 230°, the percentage of variation of resistance for one degree was found to be ·267. In the same wire when annealed the percentage variation was found to be ·316. At 9° Centigrade the ratio of the absolute resistance of this wire in the hard state to that of the same wire when annealed, was 1·229. The next result relates to a wire of platinum and silver alloy. A piece of wire from a particular bar of the alloy was hardened by being drawn down through a couple of holes in a draw-plate, and in this state the variation of resistance was ·0255 per cent. per degree. After annealing the variation of resistance was ·0258. The same wire was next placed in an iron tube filled up with sand, and left all night in the fire. After this treatment, the variation of resistance was ·0344. Another specimen of platinum and silver alloy, after being heated to a very high degree and allowed to cool slowly, the variation of resistance was ·095, and the wire was as soft as pure silver and very fragile. When heated to redness and cooled suddenly by the application of water, the variation of resistance was ·076; when the wire was drawn down two or three holes in the draw-plate it was ·073, showing that it had not, even after re-heating, recovered its original condition. This indicates the connection between the temperature co-efficient of wires and the degree of hardness such as to re-open the question as to the nature of a trustworthy material for a proper standard of resistance. The experiments are being continued by Mr. Taylor and Dr. Muirhead. There are one or two points to which I should like to draw the attention of the section in connection with this subject of the comparison of resistance of the standards. At the Cavendish Laboratory at Cambridge, where the original standards constructed by the Committee of this Association are placed, we had no difficulty at all in comparing single units with these standards, which comparison was effected with very great accuracy, the principal source of error being really in determining the actual temperature of the wire at the time of the operation. However, in the case of the platinum and silver standards the sensitiveness to temperature is not very great, and the practical resistance, including the error due to temperature, can be made with the accuracy of one in 10,000 without any difficulty. For practical purposes it is not enough to have certified copies of the unit, but we must have also correct copies of the multiples of the unit, particularly the 10 and the 100. The question arises how these multiples can be best constructed. Hitherto the procedure has been to arrive at the higher multiples by starting with a single unit, making another like it, then joining these and comparing the two with the one, then making another like the two, and so on, and thus build up the standard, say, of ten. But the process requires the aid of several intermediate coils if the object is merely to pass from one to the ten; and these intermediate observations have to be made with the highest accuracy. And, besides, it is a very tedious operation putting the coils together, and requires careful attention to the temperature. My object is to describe a method by which this object of passing from one to ten can be attained, but one more accurate than has been the case in the procedure hitherto. The method turns upon this principle:—I arranged three coils of German silver wire, each to have a resistance of about three units. When these three are placed in multiple arc they formed the resultant, as a single can be compared with the standard single; when, on the other hand, the three are placed in series, of course they have formed an aggregate of nine, which, by the addition of the original standard single, can be brought up to ten. In that way we require rather fewer intermediate coils. But that is not the main advantage. In this process of arcing we do not depend upon the accuracy of the threes which we use in the process. The principle upon which that depends is that if the sum of three resistances be given, then the resistance in multiple arc, when the three are placed in multiple arc, will be the maximum when the three are all equal. And although the three may not be quite rigorously equal, still the resistance in multiple arc is exceedingly near to the truth. All that remains then is to contrive a simple method of making the observations so that the two comparisons can be made to follow one another as quickly as possible. The first comparison consists in putting the three coils in multiple arc, and then comparing them with the standard single; and secondly, putting them in series, and then comparing the ten, or whatever you have arrived at, with the standard ten, which it is the object to test.

There are strips of very long copper plates placed between a planed board. Holes penetrate to the copper plates, and into these mercury is poured. These are the electrodes by which you can make

connection with the instrument. The three holes in which these are arranged are coupled with the single piece of brass tube. The six ends of the coils are connected with these six legs of copper, which project downwards and form the six legs of instrument. Therefore by this means we have the three coils in multiple arc and a resistance nine times less than when combined in series. The next part of the operation consists in displacing the set of three coils laterally, so that from being joined in multiple arc they are now joined in series. The electric current passes to the first cup, then through one of the coils into the lower part of the other, passing along the board to the left hand till it has passed through the whole in series. By this means, then, we have a connection made with the standard single, so that by one simple observation on one multiple arc and a single you can compare the resistance of the three coils with that of the standard single itself. Of course the resistance will not vary much in one experiment. It is therefore of advantage to make the one operation follow the other as quickly as possible, and allow little time for temperature change to enter, and in this way it is extremely easy to compare a 10 or a single with any other auxiliary coils than themselves. It is ready for use at any time. In testing a very rough accuracy is all that is wanted in the component coils. Any error arising from the use of the apparatus would be immaterial. I think the same method might be advantageously used to pass up by hundreds, that is, by using a resistance of 30 instead of a resistance of three, which when put in series will give 90, and then by the addition of the original 10 you will get 100.

APPLICATION OF ELECTRICITY TO THE RAISING OF THE WATER SUPPLY FOR THE TOWN OF LA ROCHELLE.

SINCE 1864 the town of La Rochelle has been supplied by a canal, which conducts the waters from the Lafont spring by an aqueduct into a subterranean reservoir, from whence two vertical balance machines of the Tarcot system, of 15 horse-power each, raise them to the water tower placed upon the culminating point of the town, at a height of about 20 metres. After thirteen years' service the level of the waters has fallen below the bed of the aqueduct supplying the reservoir. It therefore became necessary to hollow out a second gallery at two metres below this bed, and to raise the water from this gallery into the aqueduct leading to the reservoir by means of a rotary pump. This rotary pump is placed at 800 metres from the raising machine, and was actuated by a small separate locomotive, which was very expensive to work, and necessitated the continual presence of two men entirely occupied with this separate machine. Things were thus when M. Groc, Director of the La Rochelle Waterworks, conceived the ingenious idea of utilising the surplus motive force available upon elevating machines for working the rotary pump by means of an electric transmission of power to a distance.

This idea has been realised and the system has been in continual use since the month of July, 1881, without presenting the least difficulty and without interruption.

The transmission is performed by the aid of two Gramme machines with flat inductors of the pattern called "5-lighters." The generator makes 1,300 revolutions, the receiver about 800. This speed varies, moreover, a little with the level of the water in the lower gallery, a level which varies the work produced by the pump.

The line which connects the two machines is aerial; it is supported upon telegraph poles, and is 800 metres long. It forms a complete closed circuit. Each of the conductors is composed of two iron wires, of six millimetres diameter, fixed upon porcelain insulators, connected at intervals by transverse wires. The result is that if one of the wires is broken at any point whatever, the whole current only traverses the remaining wire over a length equal to the distance which separates two transverse joints of the double wire, the increase of resistance which ensues is then very small, and practically insensible. The line is represented by a double wire of six millimetres diameter ($\frac{1}{4}$ inch), and 1,600 metres long. Its resistance is about 3·5 ohms.

The work produced by the pump, in raising water, is equal to 140 cubic metres per hour raised to a height of two metres, that is to say, a little more than one horse-power. The force actually transmitted is about two horse-power. The work of the rotary pump in raising water is equal to one-tenth of that produced by the raising machines; the expenditure of steam is increased about one-sixth by the putting in action of the rotary pump. This is an insignificant expenditure in consideration of the special conditions of the installation. One workman only is required, placed near the pump, to oil the dynamo-electric machine and the pump. It will even be possible to dispense with him by providing the apparatus with oiling mechanism of sufficient capacity. One visit each day before the setting in motion will then make sure of the operation of the system without special supervision.

The motion of the pump is given by friction; to this end the dynamo-electric machine oscillates around a horizontal axis parallel to its own, placed at the lower part of the building. Its axle bears two pulleys, the rims of which are covered with leather, placed opposite two pulleys of a larger diameter placed upon a fixed arbor. By means of a manipulating lever, the axle of the machine is drawn towards or away from the fixed axle which controls the rotary pump by means of a transmission by pulleys and belts. The pressure of the friction pulleys is regulated by means of a manipulating lever kept in its place by a screw.

To put it in motion and also stop it, we begin by drawing away the transmitting motor, in such a manner that it turns freely.

Thus any extra current at the moment of stoppage when the circuit is interrupted is avoided, and any sudden shock at the moment of setting in motion. This is a most interesting and most suitable application of the transmission of power to a distance. No means of transmission at present known would have solved the problem with so much simplicity and elegance. We are glad to call attention to such applications, for they show much better than all the theories in the world, what powerful resources electricity offers to us when we know how to make judicious use of it.

NEW PROCESS FOR THE RAPID FORMATION OF SECONDARY COUPLES WITH PLATES OF LEAD.

WE know that the method employed for a long time by M. Planté for forming accumulators consisted of a sort of electro-chemical tanning of the plates produced by the passage of the current into the couple several times in reversed directions, taking care to allow intervals of repose between each change of direction.

This method gives layers of peroxide of lead and of lead reduced to a crystalline state adhering perfectly to the remainder of the plate which is not attacked, but it requires a tolerably long time, especially at the commencement.

To facilitate the attacking of the lead by the action of the primary current, and to accelerate the formation, M. Planté has made experiments and discovered that good results can be obtained by raising the temperature of the liquid containing the secondary couples, sometimes beforehand, sometimes during the action of the current.

The employment of heat presents, however, some difficulties in practice. M. Planté has had recourse in this case to another process, which has given him very satisfactory results, and which he has communicated to the Académie des Sciences of Paris at its sitting on the 28th August last.

This process consists of simply submitting the secondary couples to a sort of thorough scraping by means of nitric acid diluted with half its volume of water, and leaving them immersed in this liquid during 24 or 48 hours. The couples are then emptied, washed very thoroughly, refilled with water acidulated with 1-10th of sulphuric acid, and submitted to the action of the primary current. This prolonged immersion in diluted nitric acid produces the dissolution of a portion of the lead plates, but their thickness is not sensibly diminished by it. The metallic porosity produced by the nitric acid causes the ulterior electro-chemical action of the current to be exercised not only on the surface of the plates, but also on their interior; it creates new molecular intervals, and consequently facilitates the formation of the plates, considerably shortening its duration. In fact, the secondary couples thus treated can furnish, after three or four changes in the direction of the primary current, discharges of long duration, whilst, without the previous action of the nitric acid, it could only give the same results after several months' formation.

Accumulators prepared by this method seem, therefore, to present at once the advantages of couples of lead plates; that is to say, a good adherence of the deposits and the absence of the felt which maintains the minium upon the plates of the Faure couples, and at the same time the advantage peculiar hitherto to the Faure couples; that is to say, a rapid formation—a condition indispensable with accumulators intended for industrial application. It would be interesting to make new and careful comparisons between the last models of M. Faure and the new apparatus of rapid formation of M. Planté, as much from the point of view of rapidity of formation as of capacity of storage and of their effective duration in continual service.

ASSOCIATION FRANÇAISE POUR L'AVANCEMENT DES SCIENCES.

(From our own Correspondent.)

MEETING AT LA ROCHELLE.

PHYSICAL SECTION.

SITTING OF THE 28TH AUGUST, 1882—(*continued*).

APPARATUS FOR OBSERVING THE DIRECTION AND RAPIDITY OF LIQUID CURRENTS AND PARTICULARLY OF MARINE CURRENTS.

By M. BONNEAU.

THE apparatus presented by the author to the Association Française is an improvement on that which was shown at the electrical exhibition at Paris. M. Bonneau has added to it a registering system which will enable the variations in speed and direction of marine currents to be followed continuously. We shall shortly have occasion to describe it with the assistance of figures.

ON THE DISTRIBUTION OF ELECTRICITY.

By M. DEBRUN, Professor of Physics at the Lycée of Pau.

The system proposed by M. Debrun consists in inserting accumulators between the producer and consumer to provide against an accidental stoppage of the machine. The distribution must be carried out under constant pressure, the accumulators disposed in each branch of the circuit of distribution. The branch does not receive the current

directly from the main channels of distribution, but from the accumulators always in communication with the main circuit, except in cases when, by accident, the production ceases for a given time; an automatic interrupter then separates the accumulators from the main circuit, and these continue to supply the consuming apparatus, lamps, motors, &c.

The electricity is measured by passing a derivation of the current into an electrolytic vat containing cyanide of silver, and by weighing the silver deposited at the end of a given time.

To maintain a constant distribution pressure, the needle of a fine wire galvanometer, placed in communication with the terminals of the machine, closes the circuit upon two bells of a different pitch, according as the electromotive force is greater or less than its normal value. The attendant thus warned can then restore things to the normal state by altering the speed of the machines or their excitation.

NEW SYSTEM OF ELECTRIC GENERATING APPARATUS.

By Dr. BRARD, of La Rochelle.

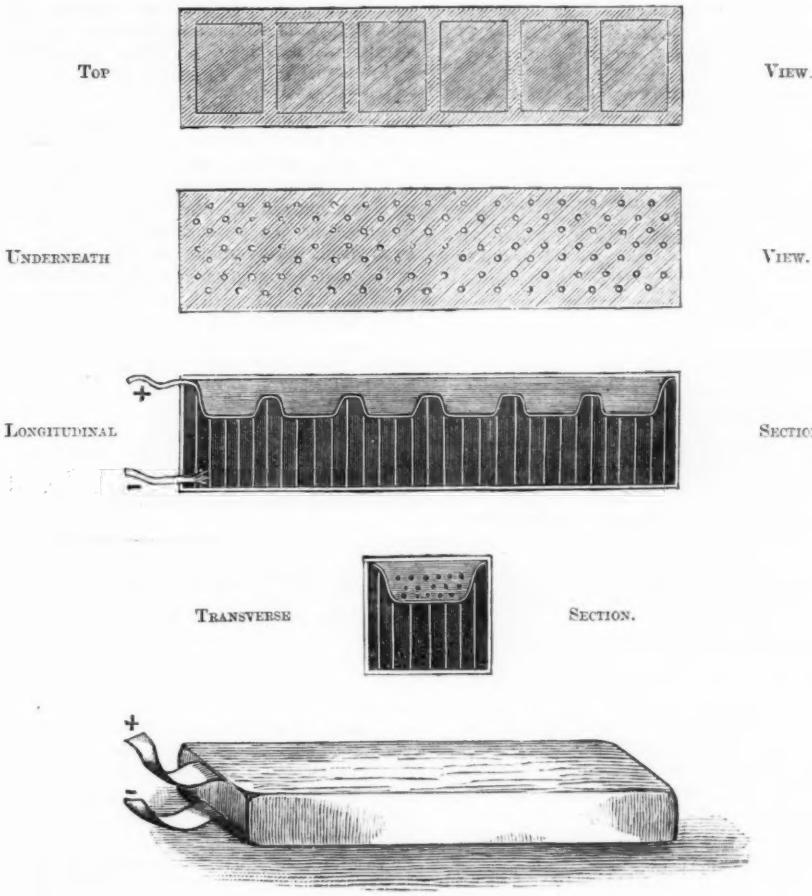
The object which M. Brard has in view in his researches is to produce an apparatus capable of transforming heat into electricity without having recourse to the complications presented by dynamo-electric machines which have been hitherto inapplicable for domestic illumination; M. Brard wishes to produce a veritable electro-generative stove, furnishing at the same time heat, light, and electricity. After having demonstrated by his experiment that thermo-electric batteries have on one hand only a feeble production, and on the other hand are soon rendered useless under the action of heat, M. Brard thinks he has found the solution of the difficulty in a thermo-chemical battery, in which the current is produced by chemical action, the combustion of carbon, under the influence of an elevated temperature produced by a special method, by the oxidising action of nitrate of potash or soda. It forms thus a veritable thermo-chemical battery, analogous to the ordinary batteries in which the oxidising of the carbon takes the place of the oxidising of the zinc and the nitrate of potash of the oxidising body. The carbon is, therefore, the negative pole, and the nitrate the positive pole of the element.

M. Brard alluded, in reference to his labours, to the experiments of Antoine-César Becquerel in 1855, and those more recently made by M. Paul Jablochkoff in 1877; he has, however, gone further than his antecedents in this way, for he has presented to the association the principal features of an apparatus actually in construction, and showed some electro-generative slabs which we are about to describe, reserving the description of the complete generator until it has been tried, and until it has undergone certain modifications which the experiments will suggest.

Electro-generative Slab.—The electro-generative slab may be defined as *a piece of prepared carbon which, when thrown into the fire, produces electricity by its combustion.* The subjoined figures which represent the exterior view of it, the longitudinal section and the transverse section, will demonstrate clearly the principle of it.

The slab presents the external appearance of a parallelopiped, about 15 centimetres (6 inches) long, 3½ centimetres (2 1-6th inches) wide, and 25 millimetres (1 inch) thick; the materials which compose it are enveloped in a sheet of asbestos paper, only two thin sheets of brass being exposed to view, which serve as conductors of the current. The interior consists theoretrically of a prism of carbon and a prism of nitrate of potash, separated by a plate of asbestos, which plays very nearly the same part as the porous cell in ordinary batteries. In practice the sheet of carbon is formed of about 100 grammes of coal-dust, formed into a paste with molasses or tar. The paste thus obtained is strongly compressed, cold or preferably with heat, in a mould of suitable form, at the bottom of which has been placed previously a sheet of copper, of brass, or any other metal which is a good conductor, cut into several strips, which are found embedded in the agglomeration of the carbon and project from one of its extremities to constitute the negative pole. The mould is disposed in such a manner that the slab is perforated throughout its thickness with numerous holes intended to facilitate combustion and to multiply the points of contact of the carbon with the nitrate, as we shall presently see. It bears besides upon the upper surface rectangular depressions 15 millimetres deep divided by transversal partitions more or less numerous, obtained by the moulding. The angles thus formed are intended to prevent the flowing of the melted nitrate into the fire during the working of the apparatus. The whole surface of these compartments is covered by a thin sheet of asbestos paper. The upper part of the brick is formed of a mixture of three parts of ashes and one part of nitrate of soda or potash. The ashes are intended to prevent a too rapid combustion, and to prevent the slab from melting. This mixture is melted and poured upon the brick very hot and in a syrupy state. About 100 grammes per slab are required, equal to about 25 grammes of nitrate and 75 grammes of ashes. A second sheet of copper or brass analogous to the first is embedded in the nitrate before cooling, and forms the second pole of the slab. The whole is enveloped in a sheet of asbestos paper.

It is sufficient to place in a fierce fire the extremity of the slab opposite to the conductors, in order to obtain in a few minutes a continuous current—and a constant one if the slab is homogeneous—during its combustion, lasting an hour and a half to two hours. M. Brard has not yet taken the constants of this new thermo-chemical battery, but in an experiment which we owe to the chemical department of the laboratory of the Lycée of La Rochelle, a single slab was sufficient to actuate an electric bell of the ordinary commercial form.



GENERAL VIEW OF SLAB.

One can, moreover, burn several briquettes at once, and group them in tension or in quantity to increase the effect. Three or four slabs in tension produce the decomposition of water.

Such are the results at present obtained by M. Brard. Without expressing an opinion as to the future and the results which will be obtained from this apparatus, which is at present confined to the laboratory, we may observe that these researches are very interesting, and that to M. Brard must be ascribed the honour of having been the first to construct a veritable *electro-generative combustible*.

ELECTRO-CHEMICAL METHOD OF DETERMINATION OF EQUIPOTENTIAL LINES UPON PLANE SURFACES.

By M. ADRIEN GUÉBHARD.

The remarkable works of the author are of a too theoretical nature, to our great regret, to allow us to submit them here to an analysis which would necessarily be succinct, and consequently incomplete. These works have, moreover, been published at various times in the *Comptes Rendus* of the Académie des Sciences, 1881-1882. We refer our readers to them.

The programme of the Physical Section included, besides the communications which we have just reviewed, certain others which were not read owing to the absence of the writers. The Physical Section having thus practically exhausted its programme separated, electing as President of the Section for the next year M. Bertin, subdirector of the Ecole Normale Supérieure, of Paris, and as delegates, MM. Alfred Niaudet and Edouard Hospitalier.

The La Rochelle meeting closed on August 31st. The twelfth session will be held one month, from August, 1883, at Rouen (Lower Seine).

Conferences.—During the Congress two public conferences have taken place, one on the deep water harbour of La Rochelle, by M. Bouquet de la Geye, the other on the electric light, by M. Hospitalier. This conference, without any scientific pretensions, held with the object of popularising the subject, presented one peculiarly interesting point: all the electric light experiments were made by the aid of thirty Faure accumulators, charged at Paris on Sunday, sent express to La Rochelle, and employed on Wednesday evening for the conference without having sensibly lost their charge. They were used to work arc lamps, a Jablochkoff candle, a Reynier lamp, and the incandescent lamps of Edison, Swan, and Maxim. After the conference they still contained sufficient electricity to operate a Mangin projector of 200 burners. The total energy stored up represented nearly one horse-power during eight hours.

CORRESPONDENCE.

TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer, not necessarily for publication, but as a guarantee of good faith.

Correspondence should arrive not later than Tuesday morning if it is desired to appear in the following number.

ECONOMICAL ELECTRIC LIGHTING ON A SMALL SCALE.

To the Editors of THE ELECTRICAL REVIEW.

SIRS,—In South Africa we are debarred from the many advantages enjoyed by young men in England for experimenting, and the amateur scientist of limited income here gets confused and sceptical when comparing the knowledge he attains by studying the various text-books by eminent men on electrical science with those applications of the science for really useful purposes.

Men who live wholly upon the plane of science describe their and others' discoveries and inventions in such a positive and eloquent style that begets faith in the minds of those dwelling upon the lower plane of commerce and practical application, who watch with hunger and patience for the crumbs, &c. But it so frequently happens that what is published from the master's plane as a valuable practical application of a law of force is, when viewed by those who have anxiously awaited its development, a mere toy, or a piece of mechanism too delicate for hands other than those of pure scientists. Thus the outsider is deluded by the pictures descriptive of important discoveries; for he finds that when brought down upon the plane of useful application the atmosphere is too dense and they cease to exist.

I trust you will accept this as a sufficient excuse for requesting information of a useful nature upon the subject of lighting by electricity on a small scale.

Dynamo-electric machines are by far too expensive, cumbersome, and unmanageable for use in private houses. Voltaic batteries, although much cheaper (that is, involving less outlay) and more manageable, are still very troublesome when compared with the use performed.

In this country paraffine oil is the chief source of artificial lighting. What is required to supersede that method *partially*, for purposes requiring a better light, is an easily manageable, and not costly, means of applying electricity; something which would effectually replace the bulk of a battery—reduce a battery to a few cells—would accomplish what is needed. There are many who would not object to a reasonable amount of trouble to secure the advantage of a superior light. Now, a good deal is said in text-books on electrical science about the great power of "current induction coils"—that the current from a few cells of a suitable battery produces powerful effects when passed through an induction coil of even small dimensions. Dr. Ferguson writes:—"Of late years coils of great power have been constructed, *rivalling, if not exceeding, the most powerful electric machines* in length and power of spark." Yet little or nothing is said at the present time about their application to electric lighting in households. Mr. J. W. Urquhart, C.E., in his work on the "Electric Light; its Production and Use, &c.," merely mentions that some generators have been constructed upon the principle of current induction, and says they are not the most successful, and passes the subject by. This would make induction coils, from a practical standpoint, appear of no value, in spite of the fact that every scientific writer on electricity speaks so very highly of them.

Your valuable journal seems to be the only source of thorough information on these matters—so highly desirable in the interests of this rapidly developing science as a guide to the sanguine uninitiated—and I shall be glad to know if it is economical to use induction coils in place of large batteries for the production of a light for everyday use. Is the light steady produced through this medium? If not, can a small secondary battery be used between the induction coils and the lamp with the effect of steadying the light? If so, whose make is the best for real use? Can more than one lamp be used in the circuit, either in series or multiple arc? Any information of a practical nature will be esteemed.

NATALIAN.

July 21st, 1882.

[We will endeavour to answer our correspondent's letter fully in our next issue.—EDS. ELEC. REV.]

RECENT PROGRESS IN TELEPHONY.

To the Editors of THE ELECTRICAL REVIEW.

SIRS,—On reading the paper, in last ELECTRICAL REVIEW, as read by Mr. W. H. Preece, on "Recent Progress in Telephony," before the British Association, I was struck with the similarity of an experiment, and even the use of the very words, as was done and used by an old friend of mine thirty years ago. The words I refer to are put in italics in your report, and are "*to communicate across seas and channels without the aid of wires at all.*" This individual was a Mr. J. B. Lindsay, of Dundee, a man who was evidently born fifty years too soon; devoted a great portion of his time to electric lighting and telegraphy; demonstrated the practical possibility of sending needle deflections across large bodies of water, across the docks at Dundee in 1848, and 1850, across the Tay at Perth and the Dee at Aberdeen. In 1859, at the latter, city Mr. Lindsay endeavoured to demonstrate his system before the British Association then assembled there, but was barely listened to, and laughed at as a visionary.

With your permission I will be glad to give more about this uncommon man's many electrical ideas—ideas which have since become realities.

I am, &c.,

G. LOWDON,

Dundee, *September 4th*. Electrician.

[We shall be glad to receive any further communication on these matters from Mr. Lowdon, if authentic.—EDS. ELEC. REV.]

THE TELEPHONE.

To the Editors of THE ELECTRICAL REVIEW.

SIRS,—I was not so far wrong, it seems, when I remarked that "Justice" had more of *law* than of justice in his composition: for what I suspected he now admits, namely, that his letter was based not on the real justice of the question, but upon a Chancery judge's decision—which may or may not be accepted as final, and which proves nothing on the abstract point, because it does not follow as a necessary truth either that the proper evidence was placed before the court, or that the court was able to appreciate questions of electrical science. As to the "blissful ignorance" of Sir Frederick Bramwell on matters electrical, I decline to enter upon such a personal topic. But as your correspondent, "Justice," cites the judgment of Mr. Justice Fry, I have consulted a copy of that document, and I find that the learned judge lays down with great clearness and discrimination that the class of tension-regulators which Edison's claim is held to cover (in combination with a diaphragm), is a class in which the tension-regulator is made of a substance that is compressible, semi-conductive, and resilient. The judge adds, "I think, therefore, that the true meaning of the claim which I have just read, is the union of a tympan or diaphragm capable of vibrating under the sound-waves with an electric tension-regulator *having the quality* which I have just described." (I italicise the words which "Justice" has overlooked.)

Further, I am compelled to differ absolutely from "Justice" on a point of the very gravest moment.

"Justice" says: "I now merely recite the words of the decision of Mr. Justice Fry, who did not think it had been established '*that Reis's transmitter combined a diaphragm with a tension-regulator.*'" I italicise the words which "Justice" says he "merely recites" from the decision, and which "Justice" puts into quotation marks. Now I have gone carefully through the twenty-seven pages of the printed judgment delivered by Mr. Justice Fry, with the remarkable result of finding that the words which "Justice" says he "merely recites," are not to be found therein at all from the first page to the last. Mr. Justice Fry in his decision does not use those words nor anything approaching them. On the contrary, he says (see printed Judgment, p. 11, line 32): "*Such a tension-regulator as Mr. Edison invented has been discovered in Reis's instrument.*" I, therefore, deliberately accuse "Justice" of a contemptible and disgraceful literary fraud in attempting to palm off as a quotation from Mr. Justice Fry's very clear decision, words which not only are contrary to the sense of that decision, but which are not even to be found there at all.

I must absolutely and peremptorily decline to say one word more in reply to a writer who can thus abuse the name of "Justice," in order to perpetrate so palpable and monstrous an INJUSTICE.

ELECTRIC LIGHTING CONTRACTS.

To the Editors of THE ELECTRICAL REVIEW.

DEAR SIRS,—I have much pleasure in replying to Mr. Hammond's letter. My object in writing you was merely to contradict a statement which, unless explained away, might have had a detrimental bearing on the Pilsen Company. Mr. Hammond's explanation is in every way satisfactory, and I regret that he should consider that any imputation was made by me, and assure him it was not intentional.

I remain, Yours faithfully,

JAMES BEATTIE.

6th September, 1882.

MANGANESE.

To the Editors of THE ELECTRICAL REVIEW.

DEAR SIRS,—Will you kindly, through the medium of your columns, give me some information about Manganese. We have several mines of it in this district lying idle. A trial shipment was sent to London (some 50 tons) a few months back, but no returns are yet to hand. I should like to know something of the different kinds that are at present in demand, and of the mode of reducing the ore. If I am asking for more information than you can afford to give in your columns, would you kindly let me know in what works I could obtain it. AN OLD SUBSCRIBER.

Port Curtis, Queensland, *8th July*.

[Owing to the pressure on our space we are this week obliged to leave over answers to correspondents. In the meantime perhaps some of our readers may have such information at hand as "An Old Subscriber" desires.—EDS. ELEC. REV.]

NOTES.

ELECTRICAL REVIEW.—REMOVAL OF OFFICES.—On and after this date the REVIEW will be published at 22, Paternoster Row, to which address letters for the "Editors" may be sent. Business communications to be addressed to H. Alabaster, to whom cheques and post-office orders (on chief office, London) should be made payable.

THE DOMINION TELEGRAPH AND SIGNAL SERVICE.—We make the following extract from the *Dominion Annual Register*, 1881:—"A telegraphic and signal service has been established at Ottawa as a regular branch of the Public Works Department, under the management of the well-known engineer and electrician, Mr. F. N. Gisborne, the original projector of the Atlantic cable. His appointment by the Government of Canada dates from 1st May, 1879."

The following is a brief summary of important services performed under Mr. Gisborne's management:—"The construction of the coast telegraph line between Canse and Halifax, Nova Scotia, under contract with the Dominion Telegraph Company; the inspection and reorganisation of the telegraph service in British Columbia, and subsequent purchase from the Western Union Telegraph Company of all their lines and cables within the province, whereby the saving of a large annual expenditure was effected; the fitting out, under contract with the India-rubber, Gutta-percha, and Telegraph Works Company, of London, England, of the Government steamer *Newfield* as a cable ship, and the subsequent laying of the following submarine electric cables: Anticosti Island to Gaspe, Province of Quebec; Magdalen Islands to Cape Breton, Nova Scotia; Bras d'Or, Lake Crossing; Grand Manan to Campo Bello, New Brunswick; and Campo Bello to Eastport, State of Maine; all of which are in successful and economical operation. The construction under contract with Messrs. Kennedy, Bertrand and Co., of the land lines upon Anticosti, and the Magdalens, in connection with the Hon. P. Fortin's comprehensive plan for establishing signalling stations and fishery bulletins throughout the Gulf of St. Lawrence and shores of the Dominion; the construction under contract with Messrs. Robinson and Co., of the land lines upon Grand Manan and Campo Bello Islands; the erection, under agreement with the Dominion Telegraph Company, of a land line between Bay St. Lawrence and Sydney, Cape Breton, Nova Scotia. The submergence, under Mr. Gisborne's supervision, of the following electric cables: Saanich Arm-Nanaimo to Gabriola, Vancouver Island; Valdes Island to Point Gray, British Columbia; also the raising and repair of six old cables upon the San Juan Island route; the construction (now in progress) under contract with the Montreal Telegraphy Company, of land lines between Baie St. Paul and Chicontimi, and Murray Bay, towards Point des Montes."

It will be seen from the above that Mr. Gisborne's services have been of a most valuable character, and are held in high appreciation, not only by the Government, but by the people and press of the country generally.

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY'S CABLE SHIPS.—The *Panama Star and Herald* of the 10th ult. gives the following information as regards the movements of the repairing vessels of the West India and Panama Telegraph Company:—St. Thomas, August 4th.—The cable ship, *Duchess of Marlborough*, returned here yesterday from Grenada, having repaired the section between that island and Trinidad. The cable steamer, *Grappler*,

also returned to harbour for a supply of steel wire grappling rope, which was quickly transferred from the *Duchess*, and the latter having coaled, both steamers left early this morning to effect the repairs of the St. Thomas and St. Kitts section. The *Grappler* has already been occupied on this nearly five months, during which time she lost several thousand fathoms of valuable steel grappling rope, grapnels, and buoys. She is now working in over one and a half miles of water. This great depth, and the irregular and rocky nature of the bottom, are retarding operations. The weather lately has been rough, and has washed the buoys off the cable when, with calm weather, it would only have been a matter of a few hours to complete the work. This cable when repaired will be practically a new one. The whole of the line from St. Kitts to within about twenty miles of St. Thomas having been submerged during the last twelve months.

AUTOMATIC ELECTRIC SIGNALLING ON RAILWAYS.—An evening paper, prone to indiscreet dabbling in scientific matters, says that "a tolerably complete scheme of the kind was invented and patented several years ago by Sir David Salomons, and it has been re-invented and patented two or three times since." The fact is Sir D. Salomon's invention was not patented till October 13th, 1874 (No. 3,515), whilst a similar device had been invented and patented by Mr. W. T. Whiteman as early as January 22nd, 1874 (No. 270).

ELECTRIC RAILWAY IN SWITZERLAND.—From Switzerland it is reported that an arrangement has just been concluded by Mr. Pearson, of the London firm of John Taylor and Co., on behalf of a syndicate of English capitalists, and Mr. Theodore Turrettini, acting for the local government, for the construction, on the Edison system, of an electric railway from St. Julien, in Savoy, to Ferney, and thence to Geneva. The total length of the line will be about 16 miles.

THE GERMAN RAILWAY ACCIDENT.—The telegrams from the continent agree that the appalling railway accident which happened near Hugstettin on Sunday last, when upwards of fifty persons were killed and numbers injured, was caused by a telegraph pole having been thrown across the line during a thunderstorm. As we may shortly expect stormy weather, it is, perhaps, not too much to ask the railway companies to cause their lines to be carefully examined, so that a similar catastrophe in our own country may not be chronicled.

THE TELEGRAPH ARRANGEMENTS OF THE ARMY.—The telegraph arrangements of the army in Egypt are ordered to be under the commanding officer of the Royal Engineers, and to be divided into two portions—that in front of the advanced depôt, and that between the advanced depôt and the base of operations. Arrangements have been made for detachments of soldiers to patrol all the telegraph lines to prevent the wires being cut or tapped by the enemy, and for military guards to protect the telegraph stations. Stores have been sent out for 12 stations. In addition to the necessary telegraph waggons and reels, there have been sent 24 "sounder" instruments for the dozen stations, and 15 Morse recording instruments for field work, together with 360 rolls of Morse paper, 48 Leclanché 10-cell batteries, 500 insulators, 200 iron telescopic telegraph poles, a large number of wood poles, 12 lightning protectors, 12 wheels for cipher signalling, 1,200 yards of copper wire covered with gutta-percha, 36 miles of insulated copper wire, and 36 miles of insulated galvanised iron wire. In addition to the above, the Royal Engineers have taken out an assortment of stores for army signalling, *i.e.*, effecting communication by means of visual signals between different posts in forts and military stations. Among these are 36 hand-draw telescopes for field observations, 72 gas-bags, and 36 pressure-bags for the lime light for night signalling, 36 lime light lamps, 72 large powerful bull's-eye signalling lamps, 36 heliographs, 36 fog-horns, and 72 army signalling flags and poles. Altogether, the telegraphic and signalling arrangements of the campaign are said to be the most perfect of those of any army which ever took the field.

TELEPHONING EXTRAORDINARY.—According to the Bradford *Daily Chronicle*, a well-known reciter gave "As you like it," the other evening, in the Technical School. The Telephone Company, which has subscribers in Halifax, Leeds, Dewsbury, and Huddersfield, supplied them with a treat, for there were placed on a table on the platform several different kinds of transmitters, thus enabling all their subscribers, who were miles away, to hear the recitation. The subscribers at Leeds, during the evening, notified that in addition to hearing the elocutionist, at the finish of each act the applause of the audience was quite audible. Each evening, when a performance takes place in the hall, it is to be heard at the various towns where subscribers reside. At one of the chapels in Halifax the telephone is fixed to the head office at Bradford, and it is said that each Sunday the service is heard in Bradford.

THE TELEPHONE CABLE ACROSS THE TAY.—On Monday the Dundee Harbour Trustees considered the application of Mr. Young, District Engineer of the National Telephone Company, Limited, for permission to lay a telephone cable near to the Post-office cables at West Ferry, for the purpose of connecting Dundee to Fifeshire. The meeting resolved that the Harbour Trustees, in so far as they are interested, assent to the laying of the cable by the aforesaid company at the place referred to, on the company obtaining the consent of the Board of Trade to the proposed operation.

THE FRENCH ATLANTIC CABLE.—We observe that the steamer *Scotia*, Captain Cato, belonging to the Telegraph Construction and Maintenance Department, left Plymouth on Saturday, to renew her efforts at repairing the French Atlantic cable. This, after being repaired a thousand miles from Plymouth, again parted within 20 miles of the original breakage. The *Scotia* has taken coal and provisions for two months.

QUICK RETURNS.—The Eastern Telegraph Company are said to be realising by the war in Egypt a daily revenue of £6,000. This income is derived exclusively from the despatches—official and press—sent from the headquarters of the army on the Canal and from Alexandria. Until the outbreak of the war there was no direct telegraphic communication between Port Said and Alexandria. The Eastern Company laid a cable from Alexandria to Port Said, at a cost of £24,000 and this sum was paid off by the revenue of four days.

ELECTRIC LIGHTING AT EASTBOURNE.—The Local Board of Eastbourne having entered into a contract for the lighting of the principal thoroughfares by electricity, on Friday the 1st inst. the Parade was illuminated by 16 Brush lights. Other lamps are soon to be in operation, the dynamo-electric machine employed being capable of producing 40 lights. Of the present installation the last lamp is at a distance of two miles from the station, and a length of cable amounting to four and a half miles is used, laid underground.

ELECTRIC LIGHTING.—At a meeting of the Aberdeen Town Council, held on Monday last, the Gas and Lighting Committee reported that, having considered the remit made to them with reference to the bill promoted by the Corporation in relation to the supply of light by electricity, they were of opinion that no action under the statute should be taken at present. This recommendation was adopted. The Lord Provost said their gas engineer might be instructed to make some experiments in electric lighting which would be productive of considerable interest to the city. He hoped the committee, in making up the gas estimates for the year, might be able to consider whether they would not set aside £200 or £300 in order that the engineer might have an opportunity at some suitable place to make experiments on behalf of the city.

A letter from the managing director of the Brush Electric Light and Power Generator Company, asking the Edinburgh Town Council to make a trial of their light on Waverley Bridge and North Bridge, engaged the attention of the Cleaning and Lighting Committee on Monday. While there is an evident chariness to further experiment with the electric light, the fact that while Princes Street is fairly well

lighted by Bray's gas burners, it is at a cost greater than the electric light; that the terms now proposed are more favourable than those concluded last year, and that the North British Railway Company, instead of giving it up, are extending its use, will not be without their influence on the decision of the sub-committee, to whom the question has been entrusted.

THE ELECTRIC LIGHT IN ST. LUKE'S.—The *City Press* says that the vestry of St. Luke's, Old Street, has received a letter from the Metropolitan (Brush) Electric Light and Power Company (Limited) asking the consent of the vestry to the grant by the Board of Trade of a licence, under the Electric Lighting Act of last session, for the supply of electricity within the parish, to be taken into consideration at the next meeting of the vestry.

ELECTRICAL ENGINEERING.—The Hammond Company Electrical Engineering College at 2, Red Lion Square, was opened last Wednesday for its first session, after an introductory speech by Mr. Robert Hammond. We hear that the College starts with 25 pupils. Mr. H. E. Harrison, B.Sc., is the Principal.

THE RESISTANCE OF CARBON.—In the course of his paper on "Recent Progress in Telephony," read before the British Association meeting at Southampton, Mr. Preece remarks, when speaking of carbon: "It has the remarkable property of having its resistance lowered when it is heated—the reverse of metals. This observation is due to Mr. Shelford Bidwell." It is rather to be regretted that Mr. Preece did not give the date of Mr. Bidwell's discovery, more especially as Mr. S. A. Varley had entered very fully into this matter in a paper, also read before the British Association, in 1870.

ELECTRICAL APPARATUS.—We have received an illustrated descriptive price-list of apparatus manufactured and supplied by Messrs. H. and E. J. Dale, of Little Britain, London, E.C. The catalogue commences with frictional electricity, and a very complete list of machines and experimental apparatus in connection therewith is given. Magnets and electro-magnets stand next in order, followed by resistance coils, and an exhaustive selection of galvanic batteries and chemicals, some of the more important being of Dale's special construction. The patent "granule" battery is said to give exceedingly good results, four of the large cells keeping a Swan lamp of 5 candle-power in action for forty hours. Telegraphic apparatus, induction coils, telephonic and electric lighting apparatus of all descriptions, together with almost everything appertaining to electrical matters. In fact the catalogue is one of the most complete we have had occasion to peruse, and we can strongly recommend it to all desirous of purchasing electrical apparatus.

ELECTRICITY IN FRENCH LIGHTHOUSES.—A recent law of the French Legislature authorised the application of the electric light in no fewer than 42 important lighthouses on the coasts of France. The total expense of this change is estimated at about £320,000 sterling.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—At 10 o'clock on the morning of the 23rd August, the William Molson Hall, Montreal, was crowded by a brilliant and distinguished audience, to welcome the American Association for the Advancement of Science.

This the 31st annual meeting of the association is one of the most successful yet held; the list of applicants for membership being large, and the papers in the hands of the committee numbering upwards of two hundred. The retiring President, Professor George J. Brush, of New Haven, Connecticut, introduced the new President, Principal J. W. Dawson, F.R.S., F.G.S., &c., who thanked the association for the honour conferred, and said, "I accept it as the choice was in some degree determined by the wish to do honour to Canada, and to give to the meeting a character as thoroughly international as possible. Science from her serene height overlooks all the national boundaries and comprehends the whole world in her scope of vision. It becomes us, therefore, for the time being to merge the character of citizens of the United States of Canada in that of cosmopolitan men of science."

The President stated that the annual meeting of the British Scientific Association opened that day in Southampton, England, and he suggested that a message of greeting be cabled to it from this association, a proposition which met the approval of the meeting.

Dr. T. Sterry Hunt next addressed the association, and after several speeches of a complimentary character, the association divided into nine sections. Section B., Physics, is the only one that calls for notice in these pages. In this section Mr. W. Le Conte Stevens, of New York, read a paper on "Vision by the Light of the Electric Spark."

VISION BY MOMENTARY ILLUMINATION.

This paper was supplemetary to other papers published during the last year, in one of which Mr. Stevens had explained a new method of stereoscopy from a pair of perfectly similar pictures, by so adjusting these in position that the retinal images of them should be dissimilar, and thus the effect of depth in space obtained from the combination. He had explained these geometrically on the assumption that free motion of the eyes was possible in viewing them. The present experiments were conducted to ascertain whether the same effects could be secured when the period of illumination was so brief that no motion of the eyes was possible. Mr. Stevens explained the apparatus employed, which consisted of a reflecting stereoscope, arranged in such manner as enabled the observer to rotate the cards on a vertical axis, and at the same time to secure any desired relation between the visual lines. The electric spark was obtained from a large induction coil, and it was found that in nearly every case binocular effects were perceptible by the light of a single spark. The experiments were varied in many ways and quantitive results were obtained, to which Mr. Stevens referred. He called attention also to a peculiar stereograph, devised some years ago by Prof. Hines, of Pennsylvania, which viewed by momentary illumination showed that binocular effects are obtainable without the eyes of the observer being in such a condition as to make the perception of double images possible in any part of the binocular field of view. These experiments were performed not only with parallel vision, but also with strong convergence of visual lines, and the disturbance of judgment, due to unusual muscular conditions, was strongly brought out in this way.

AERIAL NAVIGATION PRACTICABLE.

Mr. Joseph L'Etoile, of the Department of the Interior, Ottawa, read his paper on "A Review of the Subject of Atmospheric Current, Electricity, and Gases, with a view to Practical Aerial Navigation by means of Balloons." The paper was illustrated with a proposed balloon of fish-like form with a screw at one end and a rudder at the other end. He said that the system of practical ballooning means that a balloon should ascend without loss of ballast and should descend without waste of gas. The balloon of the future should be given the shape of a fish provided with a propeller, a rudder, with gas and air pumps, and three gasometers, one for gas, one for air, and one for working the change of temperature in the balloon caused by the solar warmth, or moist in the air, so that by these means the balloonist or aeronaut can control his air vessel as easily as the engineer in his steamboat or locomotive. It is well known that when a balloon shoots up, the gas dilates, the gasometers or gauges tell the changes, and the balloonist adjusts to circumstances. A balloon built on this new plan can ascend or descend slowly, thus giving time to meteorological instruments to mark accurate changes. Charts could be made, and balloonists would know the routes of travel in the air, day and night, at any season of the year. To give an idea of the possibility of establishing those charts, the following may be *apropos*. For instance, a balloon sailing from America to Europe should keep within the lower region, when sailing from Europe to America it should sail in the high region. Why so? The reason is that cold air is heavier than warm air, consequently the cold Arctic currents prevail in high altitudes especially in northern Europe and America.

NEW COMPANY REGISTERED.

SOUTH STAFFORDSHIRE ELECTRIC LIGHTING COMPANY, LIMITED.—Capital £100,000, in £5 shares. Offices, 33, Waterloo Street, Birmingham. Objects: To produce and supply electric light, heat, and power, and also to carry on telegraphic and telephonic business. Signatories (with one share each): R. Williams, Wednesbury; T. Underhill, M.D., Darlaston; J. Smith, Wednesbury; E. Horton, Darlaston; J. C. Tildersley, Willenhall; J. Harper, Bilston; E. H. Carter and E. Pritchard, C.E., Birmingham; J. Solly, Tipton; J. Davy, West Bromwich; E. Howe, Tipton; L. Parker, Birmingham; P. D. Bennett, Edgbaston; Joseph Smith, Wednesbury; J. Slater, Darlaston. The signatories are to appoint the first directors. Qualification: £250 in shares or stock; the shareholders in general meeting will decide the remuneration of the directors. Registered August 31st, by Walter Webb and Co., 23, Queen Victoria Street.

NEW PATENTS—1882.

4158. "Apparatus for measuring and registering electric currents." A. L. LINEFF. Dated August 31.

4159. "Telephonic apparatus." J. H. JOHNSON. (Communicated by A. D'Arsonval.) Dated August 31.

4160. "Telephonic instruments." J. D. HUSBANDS. Dated August 31.

4162. "Electric lighting and apparatus, and fittings to be used therefor." T. T. SMITH. Dated August 31.

4168. "A new or improved carbon for use in arc or incandescent electric lamps, also applicable as the porous plates of secondary or polarisation, or other batteries or instruments, and for other analogous purposes." H. J. MARSHALL. Dated September 1.

4178. "Secondary or storage batteries." D. G. FITZGERALD and T. J. JONES. Dated September 1.

4180. "Manufacture of carbons for incandescent electric lamps." J. JAMESON. Dated September 1.

4186. "Voltaic batteries." L. HARTMANN. Dated September 2.

4192. "Electro-hydraulic meter for the measurement of electric currents." R. HAMMOND and L. GOLDENBERG. Dated September 2.

4198. "Galvanic batteries." E. B. BURR and W. T. SCOTT. Dated September 2.

4212. "Production and treatment of carbonised material to be used for filtration, and in the construction of electrical batteries, and for other purposes. J. H. JOHNSON. (Communicated by A. Caron.) Dated September 5.

4220. "Improvements in the electrical regulation of steam and other power engines and pumps, and in apparatus to be used therefor." A. W. L. REDDIE. (Communicated by A. Krásza and J. Schaschl.) Dated September 5.

4235. "A more simple and effective mounting, or holder, for filaments in electric incandescent lamps." L. R. BISHOP. Dated September 6.

4238. "Manufacture of incandescent lamps and apparatus therefor." W. CROOKES. Dated September 6.

4246. "Electric signalling apparatus, chiefly designed for telephonic purposes." W. R. LAKE. (Communicated by J. H. Cary.) Dated September 6.

4248. "Galvanic batteries." G. C. V. HOLMES and S. H. EMMENS. Dated September 6.

4250. "Dynamo-magnetic electric machines and magnets to be used in such machines, and for other purposes." T. DONNITHORNE. Dated September 6.

4251. "Obtaining and utilising electric currents." T. SLATER. Dated September 6.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1881.

5578. "Transmission of motive power." W. G. S. MOCKFORD. Dated December 20. 2d. For this purpose, in place of using an endless cord or rope working over V grooved pulleys on the two shafts, or a band working over band pulleys, as heretofore usual, the inventor employs an endless cord or wire, or rope or chain, twisted with one or more twists or turns around a pulley or wheel on each of the shafts. In this way the cord, wire, chain or rope will have a great hold upon the pulleys, so that even when extremely slack there will be no slip of the cord, wire, chain or rope over them. In many cases it is sufficient to use a plain piece of wire, but in other cases wire rope would be preferable. (*Provisional protection not allowed.*)

5632. "Construction of incandescent lamps." J. S. SELLON. Dated December 23. 2d. This invention relates to the employment as a substitute for transparent glass as now ordinarily employed in the construction of incandescent lamps of such glass as is known as opal, that is to say, a semi-opaque or non-transparent glass. In carrying out the invention, the inventor either constructs the glass or bulb of the lamp of glass which has been rendered opalescent through its entirety or which has been rendered partially opalescent either by means of an internal or external lining, enamel coating, or application of an opalescent material. It will be understood that the bowl bulb or glass to be employed in the construction of incandescent lamps may be rendered either wholly or in part opalescent, that is to say, that either the inferior, the middle, the lateral, or the superior portion or the whole of the bowl bulb or glass may be coated or rendered opalescent. (*Provisional protection not allowed.*)

1882.

198. "Electric block signals, &c." J. RADCLIFFE. Dated January 13. 6d. The electric locking apparatus for levers is designed with the view to prevent the signalman of a railway from lowering his signal or shifting his points until he has received the signal "line clear" from the station or signal box in advance. In the improvements the inventor insures the locking of the signal lever by means of a vertical or nearly vertical bolt or bar, suspended from its upper end over a projecting tongue or shoe attached to and forming part of the clip-lock of the lever. A link attached to the armature of an electro-magnet is connected with the bolt or bar. The electro-magnet is connected by the conducting wire with the block-signalling telegraph instrument at the station or signal-box in advance, and in such a manner that an electric current is only passed to the electro-magnet when the block-signalling instrument is at "line clear."

297. "Galvanic batteries, &c." J. HIGGIN and A. J. HIGGIN. Dated January 20. 6d. Has for its principal object to lessen the cost of the production of galvanic currents by means of batteries and to this end elements and materials are employed which will furnish useful and valuable chemical products. In the description of battery which is considered to be most suitable to the purpose tin is employed for one element and carbon for the other, and dilute sulphuric acid for the exciting medium. In one form of a battery cell there is used a receptacle such as a stoneware jar in which is a hollow cylinder of tin with an inner porous cell containing a carbon rod or plate, which is surrounded with granular pyrolusite or manganese peroxide, which is used to absorb developed hydrogen. During the action of such a battery the action of the dilute sulphuric acid produces proto-sulphates of tin and of manganese which remain in solution. When it is desirable to renew the exciting liquid the solution obtained from the battery is treated in order to obtain such preparations of tin as are required in the dyeing and printing of textile fabrics and in other industrial processes. It is preferred to heat the solution with an added quantity of oxide of manganese, whereby the proto-sulphate of tin is converted into a per-sulphate. It is then only necessary to dilute the resultant with water in order to precipitate stannic acid or oxide from which other preparations of tin may be obtained by the employment of suitable or ordinary processes.

300. "Fire-extinguishing and alarm apparatus for use in theatres, &c." W. R. LAKE. (A communication from abroad by H. S. Maxim, of Brooklyn, New York.) Dated January 20. 8d. Has for its object to provide improved apparatus for automatically giving an alarm in case of fire and for extinguishing the same, the said apparatus operating by electricity and being caused to work by the action of the fire upon certain appliances suitably arranged.

339. "Regulating electric lamps." ERNEST DE PASS. (A communication from abroad by Bruno Abdank, commonly called Abakanowicz, of Paris.) Dated January 23. 6d. Has for its object to regulate electric lamps, by means of novel apparatus, or resistance balances, and which may be placed at any convenient distance from the lamps.

359. "Electric lamps." J. N. ARONSON. Dated January 24. 8d. Has for its object improvements in lamps in which several incandescing bridges or filaments are combined in one translucent globe or containing vessel, in which several globes or vessels, each with a single bridge or filament or are combined in one cluster, and in means or apparatus for bringing the said bridges or filaments of the lamp or of the clusters of lamps successively in the electric circuit automatically or by hand.

361. "Electrical conductors, or cables." W. R. LAKE. (A communication from abroad by H. A. Clark, of Boston, America.) Dated January 24. 6d. One object of this invention is to prevent the inductive action between the different conductors of a series lying adjacent one to another. Another object is, in electric cables composed of a series of wires, each and all surrounded and coated, and thus insulated with india-rubber, or gutta-percha, or restored waste, vulcanised india-rubber, or gutta-percha in any of their vulcanisable compounds, or with any other gum, or gums capable of vulcanisation, and suitable for insulation, to insure and maintain the proper separation and position for insulation of the several wires making up an electric cable, as to each other, during the process of vulcanisation. To secure the first-named object the inventor places a conductive body of considerable size, relatively to the size of the wires, close to the insulating coating of a series of insulated conductors, laid side by side, so that the electric impulses in any one of the said lines will expend their energy on the said conducting body rather than on the other lines of the series. To secure the second object of this invention the inventor places such cables in an oven, to be vulcanised, in moulds of a shape to maintain them in a practically straight condition from end to end of such moulds, and then vulcanises them in the ordinary manner, whereby the proper and relative positions for insulation of the wires on the cables are maintained, and the mould, containing a portion of a cable, being vulcanised as above stated, is made to project from the vulcanising oven, or chamber at the opposite ends thereof.

378. "Signalling apparatus for railways." W. P. THOMSON. (A communication from abroad by W. W. Gary, of Boston, America.) Dated January 25. 4d. The object of this invention is to provide a simple, reliable, and inexpensive single mechanism for use at crossings, curves, stations, and all other places at which audible or audible and visual warning is to be given when trains are approaching. (*Provisional only.*)

386. "Cores for telegraph cables, &c." W. T. HENLEY. Dated January 26. 6d. Refers firstly to the construction of a core with multiple conductors which may be used at will for a number of circuits, or for a few, or as one only, so that in an Atlantic cable, for example, for one part of the day or night it might be used as several telephone circuits, and the rest of the day or night as an ordinary telegraph cable of one circuit. This is done by a switch which, when turned in one direction, connects all the conductors in one circuit, and in the other direction connected in separate circuits from two upwards;

there must be a switch at each end of the line and at a given signal the switches must be set. The conductors are first insulated separately and then all closed in another coat of insulation, and then served with yarn and protected with wires in any well-known way; but in the improvement the core is surrounded with strong manilla or Russian hemp or strong fibrous material, laid up in closely spun yarns, which are laid round the core in long spirals and then served with galvanised steel wires of a small size, so as to combine lightness with strength; the cable is then covered with tape or yarn and compound in the ordinary way.

DISCLAIMER.

The Edison Electric Light Company's Disclaimer and Memorandum of Alteration. (Edison's Patent.) "Electric Machines and Motors." No. 1385. 1880.

CITY NOTES.

OLD BROAD STREET.

DEVON AND CORNWALL (BRUSH) ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

ON Wednesday the statutory meeting of the shareholders of the above company was held at Cannon Street Hotel, under the presidency of Mr. W. H. Owen.

The notice convening the meeting having been read by the secretary, Mr. F. B. Lidstone,

The Chairman said: Gentlemen, this is what may be termed a statutory meeting. It is the meeting which is usually held in accordance with the statute regulating joint-stock companies' proceedings. It is provided that the first general meeting should be held within four months from the formation of the company. Usually there is nothing to say at such a meeting, further than to give such information as the shareholders may desire to have, and that I shall proceed to give you as shortly as possible. The first thing I may say is that I rather regret there are not more shareholders present than I have now the satisfaction of seeing. In one sense the directors may take that as a compliment to themselves, for if any large number of shareholders had been dissatisfied with the position and affairs of the company there would have been more here to make complaint of it. The directors are glad to have the opportunity of giving you an account of their very brief stewardship, and you will probably not expect to hear that much business has been done. The very nature of the thing we have to offer to the public is not such as to admit of its instantly being shown for a purchase to be made instantly. The introduction of the electric light must be carried on very cautiously, carefully, and quietly. It is a thing, as we say in common talk, of which the thin edge of the wedge has to be got in and then it may be driven home. There is a strong interest opposing the electric light—namely, the gas interest. The people to whom the electric light is offered like generally to drive a bargain for themselves. They say, "Oh, yes, we shall be very glad to have the light, but you must let us have it at the same price as we get gas." But we reply, "You cannot have a better article at the same price." This is the way we have been met, and we shall be met in future. Still there is a prospect of doing something, particularly in Plymouth, which is a very enterprising place. Plymouth has received the offer of the light very cordially indeed. The directors are now negotiating for installing the light there. I hope you will approve the course the directors have been pursuing. They have not been anxious to jump at anything or accept always the terms offered. If they went into matters in an improvident way they would spend your money to no profit. There has been a little commencement made. There was a very extensive fancy fair in the city of Exeter recently, and the light was shown there. The hall was lighted up, and it was well done, and payment was made to the company for three days. There was a further day upon which the light was used, and which was agreed to be paid for, but has not been yet; and there was a fifth day on which the light was used, and it may be a matter of transfer. We have had the use of a cellar in the hall for storage purposes, and one will be a set-off against the other for rent. The directors are of course anxious to make money by the exhibition of the light at Plymouth to some persons desirous of having it. There would be in addition to making money an opportunity of advertising ourselves, and advertising our light; and when the light is exhibited in a business place like Plymouth, I think it is more than probable, almost certain, that the people in Plymouth will, after having seen the light, take more kindly to it than they are at present disposed to do. There are, moreover, prospects in the dockyards. At Portsmouth they use the electric light upon the Brush system. I was told, on applying to the authorities at Devonport dock, that they are now about transferring some light from Portsmouth, where it is not wanted, to Devonport dockyard, where electric light is wanted. So that there is some prospect of doing business there. I may say this, that I am rather sorry one or two shareholders have expressed some dissatisfaction at the directors not having done any business. Business can be done to any amount almost if you pay out money, but we look for a return. There is another undertaking at Penzance. There are the head-quarters of the mining industry of Cornwall. There is a very large field in the Cornish mines for the introduction of the light. Although we are not working in the colliery district, still I take it that mines are on the same footing. The electric light would be of immense service and of immense utility in the mines of Cornwall. Penzance being the headquarters, there is a good reason why we should make an exhibition upon the undertaking of Penzance paying for it. It would be a very good advertisement to us in a very large district without any expense to ourselves. I shall be happy to give any further information that any shareholder may desire if any shareholder has any question to ask.

Mr. J. S. Tyler asked whether and why the directors issued the prospectus stating that the directors had the exclusive right to use or sell in Devon and Cornwall the Lane-Fox incandescent lamp? He found on searching the patent register that on the 27th July, 1881, Mr. Lane-Fox granted a general licence to the British Electric Light Company for the use and sale of his lamp, and it seemed from the register that that licence was granted in consequence of the agreement which Mr. Lane-Fox had previously entered into with the British Electric Light Company, and in consequence of proceedings the British Electric Light Company took against Mr. Fox in Chancery. He found no revocation of that licence whatever. Even if it were revoked it had not been recorded, and that was a serious matter for this company. He should like to ask if the licence to the British Electric Light Company had been revoked; what was the position of the company in respect of the rights of the liquidator, if there should be one, of the British Electric Light Company, or the trustee in bankruptcy, if there should be one of the Lane-Fox? Then, if the answer was that the licence was revoked, he should ask how and when it was revoked, and why the directors, through their solicitors, did not take care that such revocation was registered. He further wished to know what was the exact terms of the parent Brush Company and whether any contracts had been signed or entered into by the directors since his interview with them yesterday? Perhaps he might be allowed to inform the meeting that he had not put these questions to the chairman off-hand, but that he called on the secretary yesterday and told him, as he got no satisfactory answer then, that he should put them at the meeting.

The Chairman said the questions might be formally put into one.

Mr. Tyler said he should like further to ask why the directors did not through their solicitor take care that the revocation, if such was the case, was registered. He omitted to say that the Anglo-American (parent) Brush Company do not now grant the licences they used to do. Formerly they granted licences for the exclusive right to use the Lane-Fox; now they give one for the use only.

The Chairman: Can you give us the date?

Mr. Tyler: About three months ago; after the Metropolitan.

The Chairman said that alteration was made subsequent to the formation of this company from circumstances which came to the knowledge of certain persons. The question resolved itself into this—Was it not a fact that such and such a transfer had been made—he was using his own words—whether, in fact, they had the exclusive legal right to the use of the lamp, or whether they had not? His answer was that unless the directors really supposed that they had such exclusive right they would not have issued such a statement. The company did not know of anything to the effect that they had not the exclusive right. If a fraud had been committed upon them by the sellers they had their remedy. Nothing had been signed or done since yesterday afternoon. The Anglo-American company saw the prospectus before it was issued, and if they saw anything they disapproved he took it that they would have had the honesty to say, "Well, you are preparing to use something we have not sold you."

Mr. Shippey failed to see what was the immediate hurry for winding-up the company. He was a small shareholder, and he could bring to the use of the company a lamp for mines which would return 50 per cent. for their money. It was absurd to propose the winding-up of the company when electric lighting was only yet in its infancy.

The Chairman said he thought the remark was a little beside the mark; he had heard no direct hint about winding-up the company.

Mr. Tyler said he thought the answers given extremely unsatisfactory. Was it a fact, or was it not a fact, he wanted to know, that on the 27th July, 1881, Mr. Lane-Fox granted a licence to the British Electric Light Company for the exclusive use and sale? He had carefully taken the numbers of the patents from the register, and they corresponded with the numbers in the company's book, and it was quite clear that the licence dealt with by the British Electric Light Company was that identical patent this company had the right to sell and use in Cornwall. He could not conceive why the directors wanted to go into a groove which was opposed to that of the shareholders. Some inquiries should be made. Renshaw's were very accessible. Why was not information sent for from them, asking if it was a fact that the licence was revoked? The information could be got in a minute. There had been time that morning to make inquiry. The whole thing was in a nutshell. Although he was only a young man he had had some experience.

The Solicitor: In winding-up?

Mr. Tyler: No; not in winding-up companies (laughter).

Mr. Tyler said they were dealing with promoters' nominees, practically. And in these days, when promoters' nominees were qualified by promoters' money, he thought it behoved every shareholder in a company like that to be very careful what he was about, and in view of what had been discovered on the register concerning this company, he thought they ought to appoint a small committee of independent shareholders—not officers of the company—to investigate this matter of the licence between the British Electric Light Company and the Anglo-American. If a shareholder had come to him, as a director, he should have treated him courteously; but he was not received courteously. Not an inquiry had been made, although the solicitors were on the spot with the information in their pockets. If the board considered that satisfactory he must submit that he did not. He was only the holder of twenty-five shares, but he did not like losing his money. He was of opinion that there existed that licence he spoke of, and that there existed, in consequence, the necessity for this investigation. If the prospectus was wrong there must be a question of the personal responsibility of the directors, at any rate of their solicitors. What they ought to have done was to have searched the

register. One gentleman at the meeting yesterday said that the Anglo-American had a million of money at its back. He believed it was public knowledge that that company had parted with nearly all the money they had got, and that, taking all the money they were entitled to, and taking the shares as money, the sum does not reach half a million. He was perfectly satisfied in his mind that if the licence with the British Electric Light Company still existed, the Anglo-American, to save themselves, must come down with the damage or there would be a serious question whether the directors were responsible to the shareholders. He moved that a small committee be appointed, as he had suggested.

The Chairman said the previous speaker needed to be very careful how he dared to make such statements as he had, involving a clear untruth. That gentleman said that the directors were promoters' nominees.

Mr. Tyler: No. I said in these days when directors are promoters' nominees.

The Chairman: The gentleman appears to me to desire to disclaim what——.

Mr. Tyler: No.

Mr. Maudsley: May I beg you to sit down? I am a shareholder in the Anglo-American, and a director in the Great Western, and I hold 1,000 shares in this company, and I have paid every farthing, as every director has.

Mr. Tyler: You treated me very civilly, and were the only one.

Mr. Maudsley continuing said that this company hoped one day, not only from the effect of electricity itself, but also by the combinations which some of them had in connection with these county companies, that they would be able to establish many which would be for the benefit both of sellers and consumers. He thought that the statement concerning the legal points raised between the two companies he (Mr. Tyler) had named, had nothing to do with this meeting at the present time. This company had not only the influence but the consideration of men in different companies who are working for the general good, who were trying to carry out the system which it is intended to develop. Scientific minds are at work, some of them having patents are hoping to improve upon the machinery, by which the money invested in these companies will be lowered in primary cost, and that it may become useful to all and to every one who may be ready to use it.

The Chairman said the statement that the board were the nominees of promoters could not be tolerated for a moment. He was about to say, when interrupted, that it having appeared that what Mr. Tyler said, or intended to say, had been misunderstood. It seemed to him that Mr. Tyler disclaimed that which he is supposed to have said. He wished to say that in Mr. Tyler making allusion to the board of directors of this company there was a distinct insinuation that the directors were the nominees of promoters. Not one director has received any qualifying assistance, aid, or help in any way. He thought one director having 1,000 shares was a sufficient guarantee that Mr. Maudsley meant what was right towards that company, and would not tolerate one director associated with him being the nominee of a promoter.

Mr. Tyler: But what about the licence?

The Solicitor (to Mr. Tyler): If you will come to my office I will show you the licence. The onus is now upon you. You make a statement that we have no right to the Lane-Fox. The title is perfectly good; there is not the slightest ground for your surmises.

The Chairman said Mr. Tyler had made many curious inquiries except the right inquiry, keeping aside all possibility of removing any doubt. He had established those doubts in his mind, and he had cast them out broadcast. He said, in fact, "I told you yesterday that those doubts existed; why have you not made inquiries?" He said, in fact, "Do you know what you have is worth nothing?" Well, the board did not know that to be the case, but said they would talk it out at the meeting to-day. But why did not Mr. Tyler pass a little more time in going to the solicitor whom he named? saying, "I dare say you can give me this bit of information. I am a shareholder in the Devon and Cornwall."

Mr. Tyler: They would not give me an answer.

The Chairman: Be quiet, sir. You must not interrupt me.

Mr. Maudsley: Do sit down, please, sir.

Mr. Tyler: I will sit down for any other shareholder, but I shall not for you. They would not give me an answer.

The Chairman: You must not interrupt me ("Chair, chair"). Why did you not give us time to make the inquiry? This gentleman came to the office late yesterday afternoon, when all offices were about closing, so that we had not fair time to make the inquiry.

Mr. Russell Evans (a director) said Mr. Tyler's remarks at first did not strike him as pointing to the winding-up of the company; but he could see now that whatever his views might be with regard to the licence, it was the winding-up of the company to which the tendency of his remarks pointed. He was always under the impression that when people had a large sum of money behind them they were a good mark to shoot at, if they sold what did not belong to them. The Anglo-American had a large sum of money not called up upon their shares. He thought the shareholders of the Devon and Cornwall had excellent clients to shoot at if they had not got a good thing. Mr. Tyler had no right to say that Mr. Lane-Fox was a poor man. He (Mr. Evans) felt as satisfied about everything connected with this company as he was of the licence; he should be assured that everything was perfectly safe.

The Chairman said Mr. Tyler's statement was not in order at that meeting. The seventy-seventh clause of their articles of association said that "it is provided that any member entitled to be present and vote at a meeting may submit any resolution to a general meeting provided that at least the prescribed time before the meeting he shall have served upon the company notice of motion," which Mr. Tyler had not done. The directors wished to take the shareholders entirely into their confidence, and to keep nothing back.

Mr. Phillipson: I will second Mr. Tyler's motion.

The Solicitor: Are you in arrears with your calls?

Mr. Phillipson: You are very rude to ask that question.

The Chairman: The question is asked because if you are in arrears you have no right.

Mr. Tyler: He rose because you said you doubted whether I should get a seconder.

Mr. Shippey said his heart and soul was in electricity. He felt that they should do all they could for the interest of their little baby company. He spoke thus of the company because he believed in it; he thought that there was a lot of lighting to be done in the mines of Cornwall.

After a vote of thanks to the chairman, proposed by Mr. Shippey and seconded by Mr. Underell, the proceedings terminated.

THE LONDON AND PROVINCIAL ELECTRIC LIGHTING AND POWER GENERATING COMPANY (LIMITED).

THE first ordinary or statutory meeting of the above company was held on Thursday, the 7th inst., in Cannon Street Hotel, Lord Wallscourt presiding.

The secretary, G. H. Redwood, Esq., having read the notice convening the meeting,

The Chairman said: Gentlemen, I have a short *résumé* of the company which I am going to read to you. As you are no doubt aware, this, the first statutory meeting of the company is held in accordance with the Companies' Act within four months of registration. It is not usual at such meetings to trouble you with any statement of accounts. You will, no doubt, however, be desirous of receiving some particulars of the progress of your company since the allotment of shares, which took place on May 15th last, when the number of shares allotted, including vendor's shares, represented a total share capital of, say, £69,000. In the first place, to carry out the object of the company it was necessary to take suitable premises, in respect to which some delay occurred. Finally, however, it has been arranged to rent premises at 42, Newington Causeway, in the centre of a very important lighting district, which are now being fitted up as an exhibition of the company's system of lighting. These premises will be opened for the inspection of shareholders at an early date, of which due notice will be given. I need scarcely remind you, gentlemen, that in the practical adaptation, electrical lighting is yet still in its infancy (hear, hear), entailing the greatest care and caution in taking the first steps in respect to contracts. It should be here observed, that the directors have had under their consideration contracts for various important places—Malta, the Brighton Aquarium, &c., but up to the present time no contract sufficiently advantageous has been concluded. It will be satisfactory for you to learn that negotiations are pending, which if carried out in their present shape will, it is believed, give a wholly satisfactory result. It will be, however, obvious to you, seeing the competition in the field, that to disclose at this stage the names of places or persons would be highly impolitic. The field is large, and there is no lack of business.

In conclusion, the directors recommend the shareholders to use their best exertions in the interests of the company. If any gentleman has any question to ask, we shall be glad to hear him.

Mr. Sheridan would like to ask whether the manager of the company was satisfied with the progress made up to the present time with the negotiations.

The Manager said, that having assumed office only during the last three weeks, that was rather a short data to build upon in giving expression to any opinion as to the prospects of the company. It might suffice to say that proposals were daily forwarded to the office, and estimates and contracts furnished, but as to the actual business results, it was a little too early yet to go into such matters. He hoped that at their meeting next year, in May, that a good statement of accounts would be laid before the shareholders.

On the motion of Mr. Deere, seconded by Dr. Suckling, who said that they ought to be well satisfied at having a board with such business capabilities, a unanimous vote of thanks to the chairman and directors was adopted.

The Chairman briefly responded, and the proceedings terminated.

CABLE INTERRUPTED.—The Shanghai Nagasaki cable being interrupted, messages for China can only be forwarded by the Indo-European Company's line. All messages should be marked "*viâ* Indo."

QUOTATION has been granted to the South African Brush Electric Light and Power Company, Limited, shares.

SPECIAL Settling Day has been granted to the Provincial Brush Electric Light and Power Company, shares; and also to the South African Brush Electric Light and Power Company, Limited, shares.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of August was 2,581, estimated to produce £2,550, against 2,354 messages, producing £2,401, in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of August, 1882, are £1,790, as against £1,507 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in August, 1882, were £23,360 from the 1st January to 31st August, 1882, £160,560, in the corresponding months of 1881, £158,240, and in the corresponding months of 1880, £154,075.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending 1st September, 1882, were £2,464, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

West India and Panama Telegraph Company (Limited). The estimated traffic receipts for the half-month ended the 31st August are £1,962, as compared with £1,763 in the corresponding period of 1881.